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Ecology of the black-tailed jack rabbit near a solid radioactive waste disposal site in southeastern Idaho

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ECOLOGY OF THE BLACK-TAILED JACK RABBIT NEAR A SOLID RADIOACTIVE WASTE DISPOSAL SITE IN SOUTHEASTERN IDAHO

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A study of black-tailed jack rabbits (*Lepus californicus*) was conducted from July 1982 until October 1985 at the Radioactive Waste Management Complex (RWMC) of the Idaho National Engineering Laboratory in southeastern Idaho to evaluate the potential role of this species in radionuclide transport. Population estimates during annual summer highs were 2.76±0.25/ha in 1982, 0.91±0.11/ha in 1983, and 0.40±0.04/ha in 1984, compared to near zero each winter. Radio-telemetry provided summer home range estimates of 31.0(±12.4) ha. All radio-collared jack rabbits departed RWMC in late fall and traveled as far as 57.3 km ($\bar{x}$=16.2±13.2). Disturbed habitat at RWMC was utilized more during nights; natural habitat more during days. Crested wheatgrass (*Agropyron desertorum*) and summer cypress (*Kochia scoparia*), which were associated with disturbed sites, were the 2 most abundant plants in diets. The potential for radionuclide transport from the RWMC is discussed even though body tissues did not have significantly elevated radionuclide concentrations.

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INTRODUCTION

The black-tailed jack rabbit (Lepus californicus) is widely distributed in the western United States (Hall and Kelson 1959). Dramatic fluctuations in numbers of this hare occur on the Idaho National Engineering Laboratory (INEL) in southeastern Idaho and on most of the northern portions of the species' range (Palmer 1897, Nelson 1909, Vorhies and Taylor 1933, French et al. 1965, Wagner and Stoddart 1972, Johnson 1979, Stoddart and Knowlton 1982, Anderson and Shumar 1986). Population density on the INEL were estimated from spotlight transects as 2.7/ha in June 1981 (near the peak of the cycle), 1.0/ha in June 1982 (when this project was initiated), and 0.02/ha in June 1984 (Anderson and Shumar 1986).

At high densities, jack rabbits create management problems for agricultural interests near the INEL. An estimated 64,000 jack rabbits were killed at Mud Lake, Idaho, on the northeastern edge of the INEL (Fig. 1) during the winter of 1981-82 (MacCracken and Hansen 1984). During periods of high population density, jack rabbits may also present special management problems near some INEL installations where soils, plants, and animals contain elevated levels of radionuclides (Markham et al. 1978, Craig et al. 1979, Halford et al. 1981, Arthur 1982, Arthur and Markham 1982, Connelly 1982, Markham and Halford 1982). Jack rabbits, having potential for long-distance movement, could transport radionuclides away from contaminated areas if these nuclides accumulated on or in the bodies of the animals.

Naturally occurring radionuclides, as well as those distributed throughout the biosphere from human activities, contribute to background radiation at INEL. Others have entered the environment from nuclear waste disposal sites. Regardless of their origin, radionuclides may become incorporated into food chains. Rates and pathways that environmental contaminants travel through food chains should be monitored (Eberhardt 1973).

The intent of my research was to describe the ecology of the black-tailed jack rabbit near the INEL Radioactive Waste Management Complex (RWMC), and to determine how its ecology influences the accumulation and dissemination of radionuclides. This information will help in evaluating the role of jack rabbits in transport of radionuclides from RWMC. Primary objectives were to determine: (1) population densities of jack rabbits at RWMC, (2) daily and seasonal movement patterns, (3) habitat utilization, (4) food habits, and (5) radionuclide body burdens.

STUDY AREA DESCRIPTION

The National Reactor Testing Station was established in 1949 by the U.S. Atomic Energy Commission as a site for building and testing nuclear reactors and support facilities. Now known as the INEL, the 230,000 ha site on the upper Snake River Plain of southeastern Idaho (Fig. 1) is administered and protected against trespass by the U.S. Department of Energy. Designated a National Environmental Research Park in 1975, the INEL is also an expansive natural environment where ecological research can be conducted with minimal human influence.

Climate and vegetation are characteristic of the northern cold desert shrub biome (Harniss and West 1973, McBride et al. 1978). Big sagebrush (Artemisia tridentata) is the dominant plant on about 80% of the area. The RWMC is near the southwestern corner of the INEL (Fig. 1) in a vegetation zone dominated by big sagebrush, green rabbitbrush (Chrysothamnus viscidiflorus), and bluebunch wheatgrass (Agropyron spicatum) (McBride et al. 1978). Crested wheatgrass (A. desertorum) was planted on many disturbed sites at RWMC, including the Subsurface Disposal Area (SDA) and old trails and barrow pits within several hundred m of SDA.

Most of the solid radioactive waste materials generated on the INEL, and radioactive waste products from other nuclear facilities, are disposed of or stored at RWMC (Fig. 2). Since 1952, the 36 ha SDA has been used for below-ground disposal of fission and activation radionuclides, including Co-60, Cs-137, and Sr-90. Other radionuclides with shorter half-lives (Cr-51, Mn-54, Co-58, Fe-59, Zr-95, Ru-103, Ce-141, and Ce-144) were also frequently disposed of in SDA. Plutonium-238, Pu-239, Pu-240, Pu-241, and Am-241 are transuranic radionuclides that were disposed in SDA. Since 1970, all incoming transuranic waste, primarily from Rocky Flats, Colorado, and all transuranic waste containing alpha activity greater than 10 nCi/g has been retrievably stored in the RWMC Transuranic Storage Area (Arthur and Markham 1978, Arthur and Markham 1983).

Approximately 8.8 million Curies (Ci) of radioactive waste has been placed in the SDA (Arthur and Markham 1983). Due to radioactive decay, however, the current quantity of radioactivity is considerably less. Buried materials consist of contaminated laboratory equipment, clothing, building materials, and other items and were packaged in containers of varying durability. Much of the activation and fission contaminated waste was uncontained. Depending on the size, shape, and nature of the contaminated waste materials, they were placed in either pits or trenches and covered with at least 0.6 m of soil.

Environmental contamination occurred when older waste containers deteriorated and when open pits were flooded (Arthur and Markham 1983). Elevated levels of radionuclides have since been detected in crested wheatgrass, Russian thistle (Salsola kali), and surface soils at RWMC (Arthur and Markham 1978, Markham et al. 1978, Arthur 1982, Arthur and Markham 1983).

METHODS

Population Density

Black-tailed jack rabbit population densities were estimated from accumulation rates of fecal pellets. A 296-point grid system (Fig. 3) established by Arthur and Markham (1978) served as a pellet collection grid. At each grid point, excluding 18 that occurred inside the Transuranic Storage Area and those that were destroyed by waste management activities prior to this study, a 1-m^2 circular pellet plot was established. All fecal pellets were removed from plots in July 1982 and discarded. Each April, July, and October from October 1982 through July 1985, all leporid pellets were collected from these plots. Mean density of jack rabbits inhabiting RWMC during the seasons that pellets accumulated was calculated using mean density of pellets greater than 8 mm in diameter (Appendix A) collected from the plots and a defecation rate of 531 ± 27 pellets per day (Arnold and Reynolds 1943). Results are reported as spring, summer, and fall/winter estimates, even though collection dates were 2-3 weeks later than calendar dates of season changes. Some plots that had been destroyed were reestablished. Number of plots cleared per sampling period ranged from 197 to 221.

Spotlight censuses provided a supplemental population index and helped to determine when seasonal population changes occurred. Jack rabbits were counted by illuminating the roadside with a spotlight while driving 15 km of roads and trails in the RWMC area (Fig. 2). The route was driven at 15-25 km per hour between one-half hour after sunset and one-half hour before sunrise on calm nights with no precipitation. Census routes were driven 1-3 times per night, 1-5 nights per month, during the months of April through November. The spotlight illuminated a strip approximately 15 m wide while censusing sagebrush areas. In the open areas of the route (SDA and barrow pits), the light beam was swept across the area to obtain a more thorough count. I recorded the odometer reading at several prominent locations along the route as well as where each jack rabbit was seen. Incidental observations, trapping success, and snow tracking were also employed to substantiate other population estimates.

Movement Patterns

Jack rabbits were captured by boxtrapping and spotlight/netting (Griffith and Evans 1970) techniques. Sex and weight of each animal was recorded. Age was estimated as juvenile or adult based upon weight and time of year. Numbered metal tags and colored plastic discs were affixed to the ears of all rabbits as individual identifiers. Collar-mounted radio transmitters, which weighed approximately 45 g, were fitted to jack rabbits with a body weight of at least 1.0 kg. Animals were released where captured.

Diurnal locations were monitored with a hand-held Telonics RA-2A (H) antenna and Wildlife Materials radio receiver. Positions of radio-collared animals were determined 1-2 times per day every 1-7 days while they remained near RWMC. Positions were occasionally verified by visual observations. Locations were recorded with reference to the distance and direction from the nearest point on the sampling grid (Fig. 3).

Nocturnal movements were monitored with a truck-mounted dual Yagi antenna system and a Telonics TAC-5 180 phase shift combiner by triangulating from 2 of 6 semi-permanent triangulation stations (Fig. 2). I determined the mean error of the system to be 40 m at RWMC by placing transmitters throughout the study area and measuring on a map the distances between known and triangulated locations.

From 1-6 jack rabbits were monitored per night depending on the number radio-collared at the time and the proximity of radio-collared rabbits to one another. From 1-5 fixes were attempted per rabbit per hour. Time between corresponding readings was kept as low as practicable. Because corresponding readings were by necessity considered to be simultaneous, those readings separated by >10 minutes were excluded from the analyses. Nightly and seasonal ranges of rabbits were calculated by the minimum convex polygon method (Jennrich and Turner 1969).

Locations of jack rabbits that moved away from RWMC were determined from an airplane with wing-mounted Yagi antennas. Locations were then more accurately obtained by utilizing the truck-mounted system, and ultimately verified on the ground.

Vegetation Analysis

Vegetation plots were inspected at RWMC between 17 July and 6 August 1984. Percent cover of plant species in the habitat was measured using a 36-point interception frame (Floyd and Anderson 1982). At 101 randomly selected grid points (Fig. 3), frames were arranged in a 3 by 3 pattern with the middle frame centered above the grid marker. Frames were placed 3 m apart with the long axis oriented in 1 of 4 randomly predetermined compass directions. Plants growing at each of the 36 points defined by the intersecting wires of the frame were identified and recorded for each frame placement.

Number of occurrences of vascular plants and other entities (bare ground, rock, litter, and moss) on each set of 9 frames were tallied and converted to percentages to estimate percent cover.

Three categories of vegetation plots were differentiated at the time the plots were inspected. These categories (natural, disturbed, and mixed) represented different degrees of human disturbance. Natural plots had no obvious human-caused disturbance (road, trail, excavation, etc.) that would influence vegetal composition on the plot. Disturbed plots were those on which vegetal composition was entirely influenced by past human activities. Mixed plots were located on edges of barrow pits or near roads and trails where vegetal development was partially affected by human activities. Sixty-one natural, 22 disturbed, and 18 mixed plots were inspected.

Habitat Utilization

Two types of available habitat (natural and disturbed) were crudely delineated at RWMC from aerial photographs partitioned into 0.33 ha grid blocks. Grid blocks that contained an estimated 50% or more climax vegetation were classified as natural blocks, the others as disturbed blocks (Fig. 4). The number of each type block that was available to rabbits was determined by counting whole blocks in a convex polygon that enclosed all blocks containing radio-fixes. Almost all disturbed habitat at RWMC was enclosed in this polygon; therefore, increasing the number of available blocks could only increase the proportion of natural blocks.

The general type of habitat utilized by radio-collared jack rabbits was determined by summing the number of radio-locations within habitat grid blocks. The number of day and night radio-fixes in each type of habitat block was compared with a chi-square test.

Food Habits

Jack rabbit diets were determined by microscopically analyzing feces that were deposited during periods of variable duration. Seasonal diets were determined from the fecal pellets that were collected to estimate population density. Spring and summer samples each represented 3 months, whereas fall/winter samples represented 6 months of jack rabbit diet. Samples representing approximately 1 week of mid-summer diet were collected during the first week of August 1982, 1983, and 1984 near the southeastern corner of RWMC. Pellets representing approximately 1 week of winter diet were collected in mid-December 1982 near Central Facilities Area (Fig. 1).

Pellets larger than 8 mm in diameter (Appendix A) were air dried for 2-3 weeks. Smaller pellets were discarded to eliminate pygmy rabbit (Sylvilagus brachilagus) pellets and to reduce the number of cottontail (S. nuttalli) pellets in the samples.

Thirty g of air-dried pellets were randomly selected from each of the collections. Each of the approximately 125 pellets in the seasonal diet samples was bisected to provide duplicate samples (Dusi 1949). August and December samples were not duplicated. Pellets were ground in a Wiley mill through a 1-mm mesh screen to render uniformity of fragment size. Random portions (8.5 g) of ground feces were assigned non-descriptive sample numbers and mailed to the Composition Analysis Laboratory in Fort Collins, Colorado, for microhistological analysis. Five microscope slides were prepared from each sample, and identifiable plant fragments occurring on 20 microscopic fields on each slide were recorded. A table indicating the percentage of each plant category identified in each sample was compiled. These categories (species, species-group, genus, and family) contained plants with indistinguishable microhistological characteristics. I grouped plants by genus, or family when genus was unknown, to simplify discussion.

Radionuclide Concentrations in Jack Rabbit Tissues

Fifteen jack rabbits were collected between 30 July and 18 August 1982. Initially, jack rabbits were sacrificed by cervical dislocation after being captured with a net and spotlight. Seven jack rabbits (1 on 30 July, 1 on 6 August, and 5 on 17 August) were collected at RWMC by this method. Eight jack rabbits were killed with a shotgun on 18 August. Four of these were shot at RWMC, and 4 were shot approximately 15 km northeast of RWMC (Fig. 1) as a control sample.

Each animal was weighed, then dissected into 3 portions. Hides were first removed to provide an estimate of surface contamination. Gastro-intestinal (G-I) tracts, with contents, were removed to estimate contamination due to recent ingestion. Carcasses, with remaining organs, represented a sample of radionuclides that had accumulated in the body. Samples were oven-dried at 60-70°C for 5-10 days. Care was taken throughout collection and preparation to prevent cross-contamination of samples.

Analyses for concentrations of gamma-emitting nuclides was performed at the INEL Radiological and Environmental Sciences Laboratory on a germanium-lithium detector coupled to a computerized multichannel analyzer system. Analyses for Sr-90 and transuranic nuclide concentrations were conducted by a commercial laboratory. Plutonium-239 and Pu-240 could not be differentiated. Analysis for Pu-241 contamination was not conducted because the procedure used was not sensitive to the decay energies of this radionuclide.

Plotted data appeared to be log-normally distributed, thus they were log-transformed. One-way analysis of variance was conducted to compare radionuclide concentrations in tissues of RWMC and control area jack rabbits.

Total radionuclide burden per jack rabbit at RWMC and the control area were estimated by multiplying the mean concentration of radionuclides in each type of tissue by the mean tissue weight, and then summing those values. An overall inventory of radionuclides in the population at RWMC was obtained by multiplying the estimate of whole-body burden by the estimated number of jack rabbits occurring there. For this calculation, the RWMC was considered to be 315 ha (the area of the sampling grid, Fig. 3).

RESULTS

Population Density

Estimates based on fecal pellet accumulations indicated that the number of black-tailed jack rabbits inhabiting the RWMC varied seasonally as well as annually (Fig. 5). Density was highest in 1982 and declined through the study period. The estimate of population density in the summer of 1982 was 2.76 ± 0.25 jack rabbits/ha. During the summer of 1983, the population was estimated as 0.91 ± 0.11 jack rabbits/ha, and in 1984 as 0.40 ± 0.04 jack rabbits/ha. Mean fall/winter population density estimates were 0.59 ± 0.06/ha, 0.18 ± 0.02/ha, and 0.08 ± 0.01/ha during the 3 successive years. Mean number of jack rabbits inhabiting RWMC during the spring was 1.21 ± 0.12/ha in 1983, 0.28 ± 0.03/ha in 1984, and 0.11 ± 0.02/ha in 1985.

Although data collected from 58 spotlight transect surveys did not yield quantitative estimates of population density, average monthly number of rabbits seen per transect (Fig. 6) exhibited a pattern similar to that of density estimates based on fecal pellet accumulations (Fig. 5).

Most of the reported fall/winter use was concentrated in October and November as telemetry and spotlighting indicated that most jack rabbits left RWMC during October and November and did not return until spring. Trapping and snow track counting revealed essentially no use of RWMC by jack rabbits during winter. During the months of December through March in the 3 years that this study was conducted, I was aware of only 1 black-tailed jack rabbit near RWMC. Winter use of RWMC by white-tailed jack rabbits (Lepus townsendii), as reported by Arthur and Janke (1986), was not observed during this study.

Exact time in spring that black-tailed jack rabbits reinhabited RWMC was not accurately determined. All but one radioed jack rabbit that left RWMC in fall either died or was otherwise lost from radio contact before spring. A radio-collared jack rabbit that left RWMC in the fall of 1982 returned sometime between 8 April and 6 May 1983. The earliest in the spring that I observed jack rabbits at RWMC was 8 April when 3 were seen in 1983.

Movement Patterns

Seventy individual jack rabbits were captured, marked, and released at RWMC to obtain information on movement patterns and habitat utilization. Twenty-two of 40 jack rabbits captured in 1982, and 22 of 29 captured in 1983 were fitted with radio transmitters. Twenty-six jack rabbits, including the only 1984 capture, were marked with only ear tags, either because they were too small to be collared or because all transmitters were in use. Eight jack rabbits were recaptured once; 1 was recaptured twice. Five ear-tagged jack rabbits were sighted 9 times. All sightings of ear-tagged individuals were within 300 m of capture locations and other sightings.

Thirty-seven radio-collared jack rabbits provided 296 daytime radio-fixes. The mean number of locations recorded per rabbit was 8.0±8.6 (range, 1-28). Seven individuals died or departed the area before any daytime positions were documented. Mean maximum distance between daytime locations of individual rabbits was 550±430 m.

On 19 nights, all-night tracking sessions were conducted on 20 different animals for a total of 61 rabbit-nights. Fifty-one of these yielded at least 6 locations and were arbitrarily considered successful. Although 6 fixes probably did not allow for a complete representation of nightly range of some rabbits, the smallest area calculated with 6 fixes, 4.1 ha, was only 0.4 ha less than the area determined by 44 fixes (the maximum). Successful nights per jack rabbit ranged from 1-6. Mean number of locations per successful session was 16.2.

Nightly polygon size ranged from 2.1 to 26.4 ha ($\bar{x}$=10.8±5.6) (Table 1). When the nightly ranges of individual rabbits were averaged, the polygons ranged from 4.7 to 17.2 ha ($\bar{x}$=10.7±3.8). Areas of polygons enclosing all jack rabbit locations (day and night) ranged from 11.5 to 57.6 ha ($\bar{x}$=31.0±12.4). Maximum width of home range polygons averaged 900±190 m.

Twenty-three of 44 radio-collared jack rabbits died at RWMC. The latest date that a monitored jack rabbit died at RWMC was 23 September in 1982 and 1 October in 1983. Of the monitored jack rabbits surviving after these dates, all 21 (9 in 1982; 12 in 1983) departed the area.

In 1982, the first marked jack rabbit left between 28 October and 1 November. Two left between 2 and 4 November; 1 left between 4 and 7 November; 4 left between 8 and 12 November; and the last monitored rabbit left between 12 and 15 November.

A jack rabbit that was captured and radio-collared on 14 September 1983 was never relocated at RWMC. This individual may have been passing through the area when it was captured, or disturbance associated with capture may have caused it to leave RWMC at this early date. All 11 other jack rabbits radio-collared in 1983 were located at RWMC between 7 and 12 October. By 4 November only 1 radioed jack rabbit remained at RWMC. This rabbit departed RWMC before 18 November.

Because of the roadless expanses of INEL, delays associated with permission for low altitude flights, poor weather conditions, obligations at the university, and interference from other similar frequency transmitters, desired expeditiousness and thoroughness in tracking long-distance movements was not attained. Two rabbits were never relocated and 13 were not found alive. Visual observations of 6 transmittered jack rabbits were secured after they vacated RWMC. Only 2 of these provided more than 1 live location away from RWMC. One had been living near the southeastern corner of RWMC from the time of its capture (1 October 1982) until 2 November. It was located 2 km northwest of its established range on 4 and 5 November. On 7 November, its radio-collar was recovered 0.75 km north of its last location. The transmitter was stained with blood. Apparently a coyote killed and ate the rabbit; coyote tracks were abundant in the immediate vicinity.

The other jack rabbit that provided multiple locations away from RWMC exhibited what may be considered true migratory behavior. This animal was located frequently at RWMC from the date of its capture (3 August 1982) until 28 October. By 1 November, it had left RWMC. A transmittered coyote on the INEL, which had a frequency identical to the transmitter on this rabbit, hindered tracking. A positive location was finally obtained on 18 February 1983 near INEL Central Facilities Area (Fig. 1), 10 km northeast of RWMC. Between 8 April and 6 May, it returned to RWMC where it was located several times in its home range of the previous year. The battery in the transmitter soon expired, so I am uncertain if it remained at RWMC or moved on.

Distances that rabbits traveled averaged 16.2±13.2 km (range, 2.2-57.3) (Fig. 7). Prior to these long-distance autumn movements, no jack rabbit had moved from RWMC. Time from when rabbits were last located at RWMC until they were subsequently relocated or until their collars were recovered often exceeded 2 months. Although predators or scavengers may have moved transmitters that were no longer on rabbits, the recovery locations probably approximate actual kill sites: Apparent predator kills at other times of year were near to where the rabbits were last located while alive.

Vegetation Analysis

Ninety species of plants were identified at RWMC (Appendix B). The 68 of these that were recorded on the vegetation plots were grouped by genus or family depending on growth form. Seven genera of shrubs, 7 genera of grasses, and forbs from 14 families occurred on vegetation plots (Table 2). An increase in grass cover and a decrease in total plant cover, shrub cover, and forb cover were apparent as the amount of disturbance on the plots increased (Fig. 8). Because data from the mixed plots were merely an intergrade of data from natural and disturbed plots, the mixed plots will not be discussed further. Natural plots contained 6 genera of shrubs, 7 genera of grasses, and 13 families of forbs. Disturbed plots contained 5 genera of shrubs, 5 genera of grasses, and 8 families of forbs.

Artemesia, the genus that covered the greatest percentage of natural plots (15.0±7.5), contributed little (1.4±3.1) to plant cover on disturbed plots. *Chrysothamnus*, the dominant shrub on disturbed plots (4.5±7.1), was the second most abundant shrub (6.5±4.8) on natural plots. Wheatgrasses contributed more to total percent cover than any other grass genus on both types of plots. Wheatgrasses grew on 93 of the 101 vegetation plots, and covered an estimated 0.3% of the area. Crested wheatgrass averaged 0.20±0.39 percent cover (0.04±0.02 on natural plots and 0.68±0.54 on disturbed plots). Within the SDA, this species covered an estimated 9.67±5.58% of the area sampled. Thick-spiked wheatgrass (*Agropyron dasystachum*) and bluestem wheatgrass (*A. smithii*), which were often difficult to distinguish in the field, when combined covered 0.5±0.9% of natural and 0.6±1.4% of disturbed plots. Bluebunch wheatgrass (*A. spicatum*) covered 0.9±1.2% of natural and 0.3±0.8% of disturbed plots. Legumes were the most common forbs on natural plots (3.3±3.8; 1.6±2.6 on disturbed plots), whereas mustards were the most common forbs on disturbed plots (3.1±5.3; 0.4±0.6 on natural plots).

Habitat Utilization

Radio-collared jack rabbits utilized the available habitat blocks (540 natural and 378 disturbed) differently during day and night. During daylight, 141 radio-locations were recorded in natural habitat blocks. This is significantly more ($P<0.025$) than the 61 daytime locations recorded in disturbed quadrats. All rabbits were associated with shrub cover during daytime locations. They were usually in areas dominated by sagebrush. Occasionally however, jack rabbits were flushed from beneath lone shrubs, either sagebrush or rabbitbrush, surrounded entirely by low herbaceous vegetation or bare ground.

At night, jack rabbits used the disturbed areas more ($P<0.001$), relative to abundance, than natural quadrats. Radio-collared rabbits were located in natural blocks 291 times compared to 364 times in disturbed blocks at night. Jack rabbits were often seen in the center of disturbed sites at night. The only times that I observed unharassed jack rabbits in the open during daylight was occasionally at dusk and dawn.

Food Habits

Microhistological analysis identified 33 plant taxa in jack rabbit feces (Table 3). Number of taxa per sample ranged from 11 to 23 ($\bar{x}$=14.9±3.3). Seasonal diet samples contained 15-26 ($\bar{x}$=19.7±3.8) taxa per sampling period (i.e., with duplicates combined). Mid-summer diet samples contained 11-15 ($\bar{x}$=12.7±2.1) identifiable plant taxa per sample.

Most taxa occurred in frequencies less than 5% (Table 3). Five genera comprised greater than 20% (reliable estimate for my sampling intensity, Holechek and Vavra 1981) of individual diet samples. *Agropyron* made up 23-53% of 11 of the 15 samples analyzed, *Kochia* made up 21-29% of 6 samples, *Bromus* made up 22-38% of 3 samples, and *Phlox* made up 28% of 1 sample. *Agropyron* was the most commonly eaten grass, *Kochia* the most common forb, and *Artemisia* the most common shrub in jack rabbit diets (Table 3). *Salsola kali*, which contained elevated levels of radionuclides (Arthur 1982), constituted <1% of RWMC jack rabbit diet.

Four genera of plants (*Agropyron*, *Bromus*, *Kochia*, and *Phlox*) were detected in all samples. Four genera (*Artemisia*, *Chrysothamnus*, *Lupinus*, and *Poa*) were detected in at least one duplicate of each seasonal sample. *Poa* was also identified in all mid-summer samples.

Proportion of grasses, forbs, and shrubs in jack rabbit diet samples varied seasonally through the study period (Fig. 9). Although forb use declined somewhat during winter, percentages of forbs in the samples were more consistent through time than were percentages of shrubs and grasses. Increased percentages of grasses in spring and summer diet samples coincided with decreased consumption of shrubs.

Conversely, increased shrub content in winter samples coincided with decreased grass content.

Jack rabbits at RWMC ate almost no shrubs in mid-summer during this study. Fecal samples that were collected in August contained 66-75% grasses and 22-34% forbs. Only a trace of shrub material was detected in the 3 samples (Fig. 10).

Radionuclide Concentrations in Jack Rabbit Tissues

Jack rabbit tissue samples contained detectable concentrations of 14 radionuclides (Table 4, Appendix C). All of these nuclides occur as background in the region either because they are naturally occurring or because of previous world-wide nuclear fallout. Cobalt-58, Sr-90, Cs-137, Pu-238, Pu-239, and Am-241 also exist as waste in SDA. A majority of the samples registered detectable concentrations of Sr-90 and transuranic radionuclides. No significant difference ($P \leq 0.05$) was detected between concentrations in any tissues between areas. Concentrations of Pu-239 and Am-241 in G-I tracts and hides, however, appeared to be higher in jack rabbits collected closer to SDA (Fig. 12, Table 5). Concentrations of gamma-emitting nuclides were at or below the minimum detection limit in most samples. Cobalt-58 was detected in a hide sample from RWMC, and Cs-137 was detected in a G-I tract and a hide from RWMC and a G-I tract from the control area.

Total radionuclide burden per rabbit was estimated to be 133.2 pCi at RWMC and 143.3 pCi at the control area (Table 5). In the summer of 1982, at the highest jack rabbit density that I observered (2.76/ha), the population was contaminated by an estimated 115.7 nCi of activity.

DISCUSSION

Population densities of black-tailed jack rabbits vary widely within and between years on the INEL. Densities at the peak in the cycle as high as 8 jack rabbits/ha have been estimated (Anderson and Shumar 1986). My study began in the year following the peak and ended before the low; therefore, my estimates do not include either extreme in the cycle of the jack rabbit population which may fluctuate greater than 100-fold (Anderson and Shumar 1986). Mean annual density at RWMC from July 1982 through June 1983 was roughly 8 times greater that during the same period 2 years later.

Jack rabbits are not evenly distributed in available habitat (Nelson 1909, Currie and Goodwin 1966, French and Heasley 1981, Johnson 1982). Throughout their northern range, black-tailed jack rabbits concentrate in certain areas during winter (Vorhies and Taylor 1933, Bronson 1957, Rusch 1965, Gross et al. 1974). Winter concentrations occur at various sites on and near the INEL (French et al. 1965). RWMC apparently lacked characteristics that dictate where winter concentrations will occur; because during this study, RWMC supported very low densities during winter.

Densities during spring and summer at RWMC increased considerably. Population densities during summer on the INEL tend to be positively correlated to the proportion of grass at the site (Johnson 1982). Grass cover was nearly twice as high on disturbed sites at RWMC compared to surrounding natural areas. Crested wheatgrass covered 2.7 times more area of disturbed sites than all other grasses combined. Westoby and Wagner (1973) reported no obvious trend toward higher populations in native vegetation immediately adjacent to crested wheatgrass, compared to areas 900 m away. Average maximum width of home range polygons that I measured equaled 900 m, thus densities in a larger surrounding area at RWMC need to be investigated before reaching conclusions about the influence of crested wheatgrass on densities in this area. Casual observations suggest that this site supported a higher density than the surrounding areas.

Seasonal changes in the number of jack rabbits at RWMC were strongly influenced by movements. All radio-collared animals departed the RWMC in fall, and essentially no jack rabbits lived at RWMC during winter. They began reinhabiting RWMC during spring while snowmelt was in process. From observations and capture success, it appeared that immigration to RWMC continued into the summer, and in combination with reproduction, accounted for highest density during late summer.

The mean size of summer home ranges that I measured at RWMC (31 ha) was larger than most previous estimates. Annual home ranges were reported as <16.2 ha (French et al. 1965), as 8-16 ha (O'Farrell and Gilbert 1975), as 12.1-22.3 ha (Lechleitner 1956), and as 2.4 ha during summer and 1.6 ha during winter (Rusch 1965). The larger ranges that I measured may have been influenced by technique; most conclusions about jack rabbit mobility were based on data from trapping studies or telemetry studies of short duration.

Past research indicated that linear movements, throughout the lives of individuals on the INEL, were generally restricted to less than 0.8 km (French et al. 1965). Where food and shelter were not in close proximity, daily movements of >1.6 km in Kansas (Bronson 1957) and 1.6-3.2 km in Arizona (Vorhies and Taylor 1933) were reported. Lechleitner (1956) reported that no jack rabbit on his California study area moved >1.2 km except for a period when flood waters forced them to move to dry areas. Despite recorded movements of 17.7 and 13.4 km by black-tailed jack rabbits in Utah (Rusch 1965), and previous documentation of a 45 km movement on the INEL (French et al. 1965), the presumption that jack rabbits do not travel long distances is widely accepted. In Utah (Janson 1946, Currie and Goodwin 1966) and in California (Grinnell et al. 1930), portions of jack rabbit populations migrate seasonally into different vegetation zones. Those authors did not report distances in their studies which involved unmarked animals. Grinnell et al. (1930) concluded that a shift in the range of a small part of a population that widened the local range of the species probably explained this apparent migration. Winter concentrations on and near the INEL were explained as short movements (<1.6 km) by the entire local population toward one central location (French et al. 1965).

My data suggest that jack rabbits commonly move long distances in an apparent annual migration. Winter concentrations of black-tailed jack rabbits may result from long-distance movements. The rabbit that traveled the longest distance in this study (57.3 km) moved to a well known concentration area near Mud Lake, Idaho. The only monitored rabbit to survive a winter did so in a winter concentration area approximately 10 km from RWMC. Rusch (1965) reported that 2 marked jack rabbits in northern Utah moved 9.7 and 13.4 km from summer home ranges to a winter concentration area.

The stimulus for the autumn movements that I documented is unknown. Seasonal movements in Utah were influenced by snow cover (Currie and Goodwin 1966). The departure from RWMC followed an accumulation of snow in 1982, but preceded snow accumulation in 1983. Migrations of snowshoe hares (Lepus americanus) have been correlated with weather (Cox 1936, Henshaw 1966) and food shortages (Windberg and Keith 1976, Keith et al. 1984). Further radio-telemetry studies should be conducted to determine the stimulus for this emigration from RWMC and to establish the ultimate destination of migrants. The impact that migration has on winter concentrations is an important feature of the ecology of jack rabbits that is poorly understood. This may have significant implications regarding the concentrations of rabbits near agricultural areas, and the control of these rabbits. Whether or not they usually return to the origin of their migration should be established: French et al. (1965) may have been misled, when they trapped rabbits that did return, to believe that rabbits do not migrate. The only radio-collared rabbit in this study known to survive a winter returned to RWMC the following spring. The fate of 2 radioed animals that departed RWMC is unknown.

Food habits, telemetry, and spotlight data suggest that high proportions of favorite foods growing on disturbed sites at RWMC attracted jack rabbits to these sites at night, the time when most feeding occurs (Bronson 1957, Lechleitner 1957). Lack of available hiding cover prohibited jack rabbits from utilizing these sites during daylight. Nearby sagebrush satisfied the requirement for security and shelter during the day while providing escape cover at night.

The most common jack rabbit foods at RWMC were grasses during spring, forbs and grasses during summer, and shrubs during fall and winter (Figs. 9 and 10). This seasonal dietary trend is typical of the species throughout much of its range (Currie and Goodwin 1966, Hayden 1966, Sparks 1968, Westoby 1980, Clark 1981). Grasses and forbs were the primary forage for jack rabbits at RWMC: Few jack rabbits inhabited RWMC during fall and winter, thus shrubs were not heavily utilized. Wheatgrasses and summer cypress, which grew primarily on disturbed sites, including SDA, were the 2 most common foods of RWMC jack rabbits. Although crested wheatgrass could not be microhistologically differentiated from thick-spike wheatgrass and bluestem wheatgrass in the diet samples, crested wheatgrass probably accounts for most wheatgrass in jack rabbit diets at RWMC. Jack rabbits eat whatever grasses are found in the habitat (Johnson 1982), and compared to the other 2 wheatgrasses combined, crested wheatgrass was nearly 13 times more abundant and occurred more than twice as often on disturbed plots. Crested wheatgrass was reported to be a major constituent of the diet of black-tailed jack rabbits in places where it was available (Westoby and Wagner 1973, Fagerstone et al. 1980, Westoby 1980). Crested wheatgrass was, therefore, probably the dominant food item throughout much of the year at RWMC and was especially important in summer, when jack rabbit densities were highest. Crested wheatgrass, which in arid environments is ideally suited as a cover to reduce erosion and to limit water infiltration above buried waste, probably attracted jack rabbits to SDA.

Soil covers in SDA may not be sufficient to restrict radionuclide uptake by deep-rooting species (Arthur 1982). Russian thistle, which contained higher contamination levels than crested wheatgrass, possibly because its roots are more likely to penetrate to buried waste (Arthur 1982), contributed little to jack rabbit diets. Summer cypress, a deep-rooting species, which was the second most abundant taxa detected in diets, was not analyzed by Arthur (1982) for radionuclide concentrations. Summer cypress and Russian thistle covered approximately equal portions of disturbed vegetation plots.

Radionuclide concentrations in black-tailed jack rabbits inhabiting RWMC were not significantly different than concentrations in animals from a control site. Concentrations of Am-241 and Pu-239, however, were slightly higher in G-I tracts and hides of jack rabbits collected nearest SDA (Fig. 12, Table 5). Small and unequal sample sizes and high variability in the RWMC samples may have masked an actual difference. Concentrations of Am-241 in cottontails collected inside SDA were significantly higher than concentrations in cottontails from a control area (Janke and Arthur 1985). Ratios of radionuclide concentrations suggest that waste products at RWMC may have been at least partially responsible for contamination of jack rabbits. The ratio of Am-241/Pu-239 expected from world-wide fallout in the INEL vicinity is 0.3, but was 3.0 or higher in contaminated surface soils near SDA (Markham et al. 1978). Crested wheatgrass and Russian thistle had ratios of 0.5 at a control area 68 km east of SDA, whereas these species contained ratios from 1.0 to 8.0 in SDA (Arthur 1982). Ratios in G-I tracts and hides of control area jack rabbits was 0.4. The ratio was 3.7 in G-I tracts and 3.6 in hides of jack rabbits collected at RWMC.

Studies of radionuclide contamination in other wildlife species at RWMC have been summarized (Arthur and Janke 1986), and indicate that potential for transport from the area by biotic mechanisms is minor. My finding support that conclusion. No difference in contamination levels was detected in jack rabbits from the 2 locations I investigated. Total burden of radionuclides in jack rabbits was approximately half of what was detected in cottontails (Janke and Arthur 1985). Strontium-90 and Cs-137 contributed 95% of the radionuclide burden in jack rabbits at RWMC and 99% in control area jack rabbits. Americium-241, which was detected in concentrations almost 30 times higher in RWMC jack rabbits than control area rabbits (Table 5), contributed the to the majority of the difference.

Although jack rabbits were not determined to be a significant factor in radionuclide transport at RWMC, they have the potential to move contaminants from areas with high contamination levels. This transport mechanism should, therefore, be monitored in areas contaminated by operations and accidents. Because of the extreme numbers during peaks in the population cycle of this species, special consideration should be given at these times. Several modes of possible contamination of jack rabbits existed at RWMC. Food sources such as crested wheatgrass and summer cypress could be contaminated from uptake via roots or by surface contamination. Jack rabbits could dust themselves (Bronson 1957) in contaminated soil then transport it externally or internally after grooming. They could also directly ingest contaminated soil.

In more heavily contaminated areas, where reduction of biotic transport may be desirable, mowing the vegetation might reduce the attractiveness to jack rabbits. In the 3 years that this study was being conducted, the SDA was mowed in late summer or early fall. This appeared to reduce its attractiveness to jack rabbits. My spotlighting data are meager, particularly as a result of the declining number of jack rabbits at RWMC throughout the study period, and because the mowing occurred shortly before the fall departure from RWMC by jack rabbits, but rabbits were never seen in mowed areas even though they regularly used them before mowing. Further research could clarify the effect that mowing has on rabbit use of SDA. The impact that mowing has on other desirable qualities of crested wheatgrass should be investigated, however, before begining a frequent-mowing project.

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Table 1. Movement patterns of black-tailed jack rabbits at the INEL Radioactive Waste Management Complex.

Jack rabbit identification number	Sex	Single-night range (ha) mean (sd)	Single-night range (ha) range	Summer home range Size (ha)	Summer home range Tracking interval (days)	Number of fixes day	Number of fixes night	Number of fixes total	Maximum diameter (m)
6	F	9.0 (0.6)	8.6-9.5	23.9	84	22	47	69	800
12	M	10.9 (9.5)	3.0-23.8	45.5	78	16	93	109	1300
16	M	4.7 (1.1)	3.9-5.5	11.5	61	12	42	56	480
17	F	9.4 (2.8)	7.4-11.4	13.3	39	3	26	29	840
18	M	11.4 (0.4)	11.1-11.6	16.7	31	3	35	38	1110
23	M	12.9 (9.0)	4.1-26.4	40.1	105	27	66	93	860
24	unknown	11.3 (6.5)	5.4-20.2	29.2	106	24	40	64	940
25	F	14.7 (4.6)	6.5-18.6	34.7	98	24	71	95	1000
28	F	8.6 (2.2)	6.5-12.0	33.2	87	18	68	86	900
29	F	5.9 (2.9)	3.4-9.7	35.4	84	20	55	75	850
31	F	7.7 (5.9)	2.1-13.8	34.1	80	16	84	100	1020
32	M	14.9 (9.4)	4.4-22.5	40.2	14	4	35	39	960
34	M	16.8 (0.6)	16.4-17.3	24.7	27	5	59	64	830
35	F	17.2 (4.4)	14.1-20.3	24.3	27	5	45	50	680
36	M	8.8 (6.7)	4.1-13.6	57.6	26	5	42	47	1110
		10.9(3.8)		31.0(12.4)					900(190)

Table 2. Percent occurrence and percent cover of 3 categories of plants and non-vascular plant entities on natural and disturbed vegetation plots at INEL Radioactive Waste Management Complex.

	Natural Plots (N=61)			Disturbed Plots (N=22)		
		Percent cover			Percent cover	
Taxon	Percent occurrence	mean (sd)	range	Percent occurrence	mean (sd)	range
Shrubs	100	24.3 (8.6)	9.9-43.6	45	6.2 (10.2)	0-31.0
Artemisia	98	15.0 (7.5)	0-34.3	36	1.4 (3.1)	0-14.0
Chrysothamnus	93	6.5 (4.8)	0-18.7	32	4.5 (7.1)	0-21.7
Gutierrezia	13	0.4 (1.1)	0-5.0	0		
Leptodactylon	69	1.8 (2.2)	0-11.7	18	0.2 (0.7)	0-2.7
Opuntia	15	0.1 (0.3)	0-1.7	4	0.1 (0.2)	0-1.0
Tetradymia	26	0.6 (1.3)	0-6.0	9	0.1 (0.4)	0-2.0
Grasses	100	5.4 (4.6)	1.0-26.0	100	10.2 (5.5)	1.0-31.0
Agropyron	89	1.9 (2.9)	0-21.3	95	8.3 (5.5)	0-18.3
Bromus	43	1.3 (3.6)	0-22.7	27	0.6 (1.5)	0-6.0
Elymus	5	0.1 (0.4)	0-2.7	4	0.2 (0.7)	0-3.3
Oryzopsis	28	0.2 (0.3)	0-1.0	14	0.1 (0.2)	0-0.7
Poa	64	1.0 (1.5)	0-7.3	0		
Sitanion-Hordeum	80	0.9 (0.9)	0-3.3	64	1.0 (1.4)	0-6.0
Stipa	23	0.2 (0.4)	0-2.0	0		
Forbs	100	12.2 (5.4)	2.3-27.3	86	9.3 (9.0)	0-32.3
Boraginaceae	28	0.2 (0.4)	0-2.0	18	0.2 (0.6)	0-2.3
Caryophylaceae	16	0.1 (0.5)	0-3.3	0		
Chenopodiaceae	0			41	1.6 (4.9)	0-22.3
Compositae	93	2.3 (2.2)	0-10.3	55	1.3 (2.4)	0-10.0
Cruciferae	48	0.4 (0.6)	0-2.0	64	3.1 (5.3)	0-22.7
Leguminosae	74	3.3 (3.8)	0-13.3	45	1.6 (2.6)	0-9.3
Lileaceae	3	<0.1 (0.1)	0-1.0	0		
Malvaceae	3	<0.1 (0.1)	0-0.7	0		
Onagraceae	15	0.1 (0.4)	0-2.3	0		
Orobanchaceae	3	<0.1 (0.1)	0-0.3	0		
Polemonaceae	80	2.9 (2.7)	0-8.6	32	0.7 (1.8)	0-7.7
Polygonaceae	21	0.1 (0.2)	0-1.0	9	0.1 (0.3)	0-1.3
Scrophularaceae	85	2.9 (2.6)	0-10.3	27	0.8 (1.6)	0-6.0
Umbelliferae	3	<0.1 (0.1)	0-1.0	0		
Non-vascular plant entities	100	58.8 (11.0)	40.3-83.3	100	74.9 (11.4)	51.0-88.0

Table 3. Vegetal composition of black-tailed jack rabbit diet, in percent dry weight, as determined by microhistological analysis of feces.

	Spring		Summer		Mid-summer			Fall/Winter		Mid-winter
	1983	1984	1982	1983	1982	1983	1984	1982-83	1983-84	1982
Shrubs										
Artemisia tridentata (type)*	1.69	10.44	2.84	2.80	0	0.73	0	17.86	11.32	39.13
Chrysothamnus nauseosus	1.48	1.41	1.28	0.83	0	0	0	1.68	5.92	10.52
Chrysothamnus viscidiflorus	0	0	0	0	0	0	0	0.41	1.32	0
Eurotia lanata	0.63	1.33	3.12	2.34	1.41	2.16	0	0	3.12	0
Leptodactylon	1.98	4.28	0.80	0	0	0	0	4.60	0.47	0
Opuntia	2.10	0.44	0	3.10	0.66	0	0	5.48	3.00	8.88
Tetradymia canescens	0	0	0	0.40	0	0	0	0	2.66	0.75
Subtotal	8.07	18.63	8.04	9.47	2.07	2.89	0	30.06	27.80	62.76
Grasses										
Agropyron smithii (type)**	30.22	19.28	29.42	31.98	53.45	32.18	28.33	16.48	14.73	0
Agropyron spicatum	0.88	0.91	0	0.46	0	1.38	1.53	0	0	0
Bromus	15.34	17.65	18.10	11.59	6.20	38.87	31.37	2.54	15.18	0
Elymus	1.06	0	0	0.85	0.51	0	0	0	0	0
Luzula	0	0	0.35	0	5.92	1.79	2.55	0	0	0
Poa	0.25	4.36	2.52	0.46	0	0	0	2.29	5.24	14.72
Sitanion hystrix	0.25	0	0	0	0	0	1.43	0.40	0	0.75
Sporobolus	0	0	0.30	0	0	0	0	0	0	0
Stipa comata	0	0	2.31	0	1.64	0	0	0	0	6.58
Stipa-Oryzopsis	1.57	0.44	0	0.78	0.75	0	0.80	3.34	0.81	0
Subtotal	52.80	45.88	64.19	48.18	72.91	75.46	66.01	26.76	37.82	22.05
Forbs										
Astragalus	0.25	0	0	0.83	0.75	1.55	1.40	0.88	1.26	0
Chenopodium album	0.76	0	0	0	0	3.47	0.68	0	1.36	3.48
Cordylanthus	0	0	0.82	0.80	0	0	0	2.28	0	0
Cryptantha	0	0	0.41	0	0	0	0	0	0	1.34
Descurania	2.40	1.31	0	2.40	0	1.43	0.74	3.12	2.22	2.78
Eriogonum (Uncertain ID)	1.30	0.80	0.42	2.46	1.56	0	0	4.86	0.92	9.58
Kochia	26.54	19.00	13.90	26.36	9.71	10.04	28.19	2.46	12.60	0
Lupinus	1.12	3.58	3.80	3.56	3.36	0	0	7.92	6.10	0
Melilotus	0.52	0	0	0.85	0.75	0	0	0	0	0
Mentzelia	0	0	0	0	0	0	0	0	0	1.49
Penstemon	0	0	0.38	0	0	0	0	0	0	0
Phlox	1.76	10.31	7.21	1.61	7.76	4.49	1.43	20.06	9.01	0
Salsola kali	1.98	0	0	1.88	0.72	0	0	0	0	0
Senecio	0.44	0	0.42	1.21	0	0.67	1.55	1.19	0	0
Umbell	0.26	0	0	0	0	0	0	0	0	0
Unidentified composite	1.06	0	0.42	0.41	0	0	0	0	0	0
Vicia	0.25	0	0	0	0	0	0	0	0	0
Subtotal	39.14	35.49	27.78	42.36	25.02	21.65	33.99	43.20	34.38	15.19

*Includes _A._ _tridentata_ and _A._ _tripartita_.
**Includes _A._ _desertorum_, _A._ _dasystachum_, and _A._ _smithii_.

Table 4. Concentrations of radionuclides (pCi/g oven dry weight) in tissues of black-tailed jack rabbits collected at the INEL Radioactive Waste Management Complex and at a control area.

Tissue	Collection location		Sr-90	Cs-137	Pu-238	Pu-239/240	Am-241
G-I Tract	RWMC n=11	$\bar{x}$(sd)	0.106 (0.057)	0.086 (0.17)	0.0008 (0.0004)	0.0039 (0.0038)	0.0143 (0.022)
		range	0.061-0.253	*BDC-0.411	BDC-0.0014	0.0008-0.0134	0.0009-0.063
	Control n=4	$\bar{x}$(sd)	0.086 (0.009)	0.089 (0.24)	0.0004 (0.0003)	0.0013 (0.0007)	0.0005 (0.0003)
		range	0.078-0.097	BDC-0.368	BDC-0.0009	0.0009-0.0024	BDC-0.0009
Hide	RWMC n=11	$\bar{x}$(sd)	0.21 (0.11)	0.038 (0.22)	0.0012 (0.0015)	0.018 (0.044)	0.065 (0.15)
		range	0.011-0.34	BDC-BDC	BDC-0.0053	0.0007-0.150	0.0009-0.51
	Control n=4	$\bar{x}$(sd)	0.28 (0.07)	0.033 (0.084)	0.0014 (0.0018)	0.0038 (0.0022)	0.0016 (0.0006)
		range	0.195-0.36	BDC-BDC	0.0012-0.0016	0.0021-0.0068	0.0012-0.0025
Carcass	RWMC n=11	$\bar{x}$(sd)	0.26 (0.14)	0.016 (0.12)	0.0001 (0.0002)	0.0002 (0.0002)	0.0006 (0.0010)
		range	0.107-0.640	BDC-BDC	BDC-0.0006	BDC-0.0009	BDC-0.0035
	Control n=4	$\bar{x}$(sd)	0.27 (0.08)	0.038 (0.033)	0.0001 (0.0002)	0.0002 (0.0001)	0.0001 (0.0001)
		range	0.202-0.380	BDC-BDC	BDC-0.0004	BDC-0.0003	BDC-0.0002

* Concentration below minimum detectable amount.

Table 5. Average concentrations (pCi) of radionuclides in black-tailed jack rabbits at the INEL Radioactive Waste Management Complex and at a control area.

Location	Tissue	Radionuclide					
		Sr-90	Cs-137	Pu-238	Pu-239/240	Am-241	Total
RWMC	G-I Tract	5.5	4.5	0.043	0.21	0.75	11.0
	Hide	14.8	2.7	0.083	1.29	4.59	23.5
	Carcass	114.6	0	0.055	0.09	0.27	115.0
	Whole Body	134.9	7.2	0.181	1.59	5.61	149.5
Control	G-I Tract	5.6	5.7	0.028	0.08	0.03	11.4
	Hide	21.8	2.5	0.107	0.29	0.13	24.8
	Carcass	93.4	12.9	0.041	0.07	0.05	106.5
	Whole Body	120.8	21.1	0.176	0.44	0.21	142.7

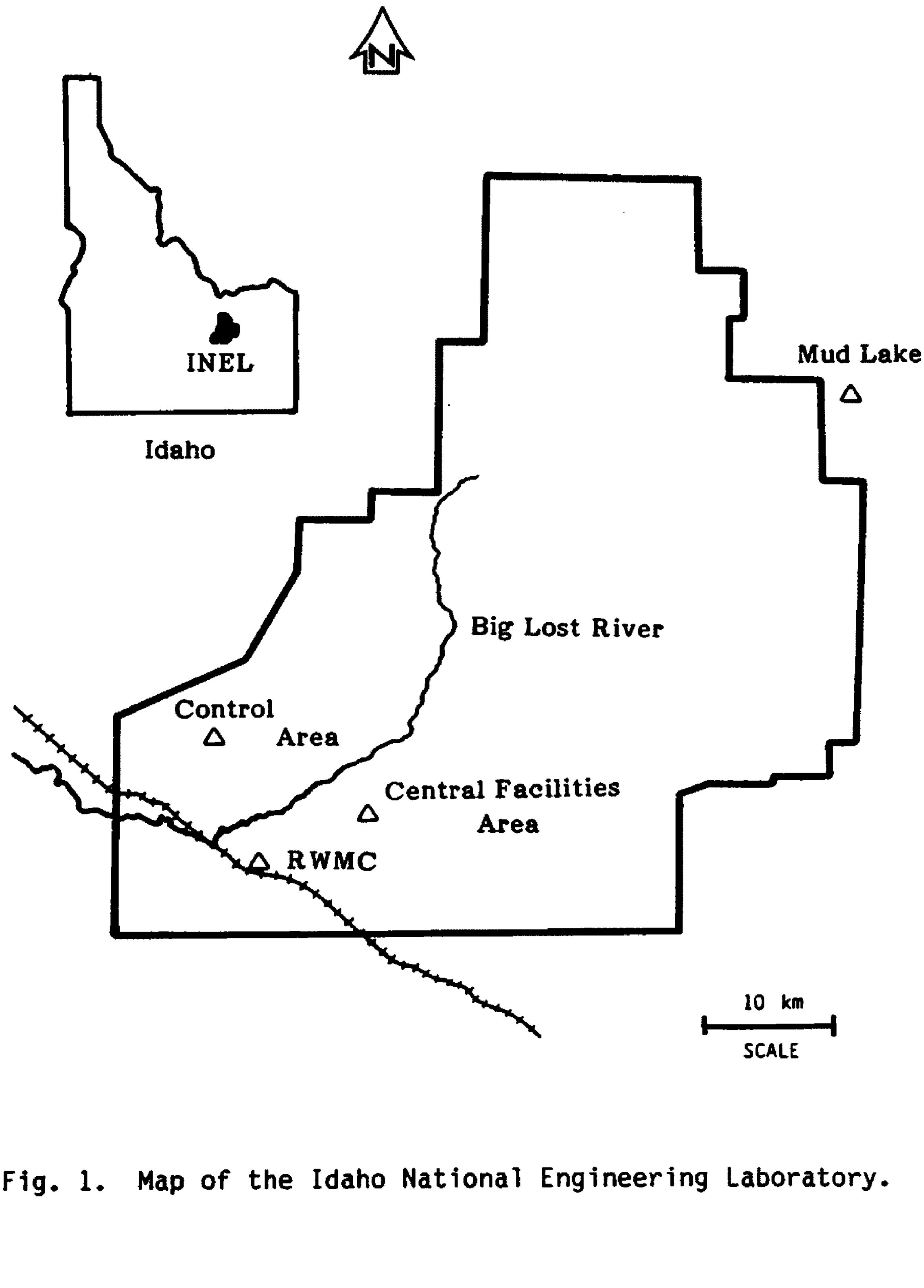

Fig. 1. Map of the Idaho National Engineering Laboratory.

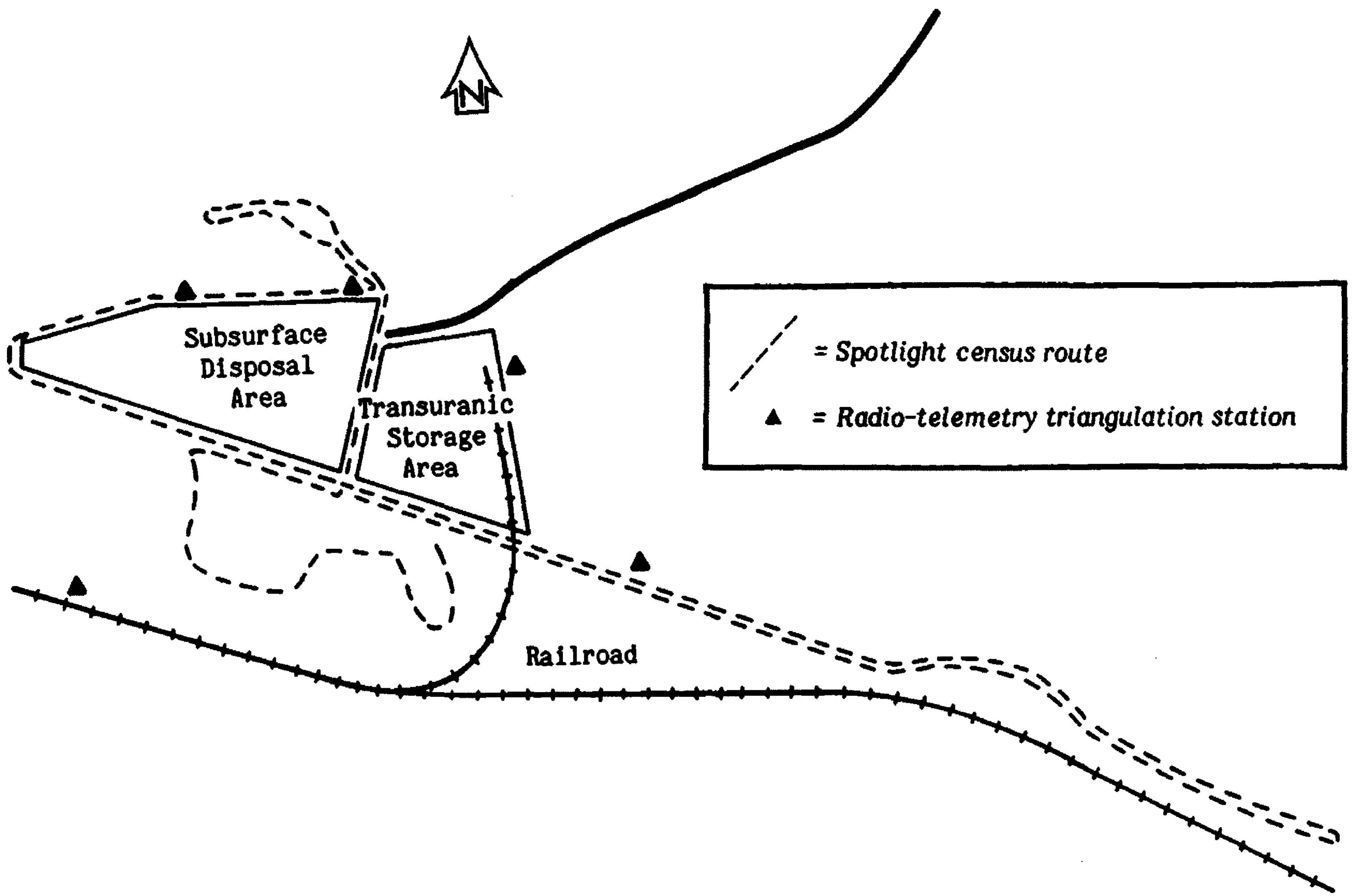

Fig. 2. Locations of radio-telemetry stations and spotlight census route at the INEL Radioactive Waste Management Complex.

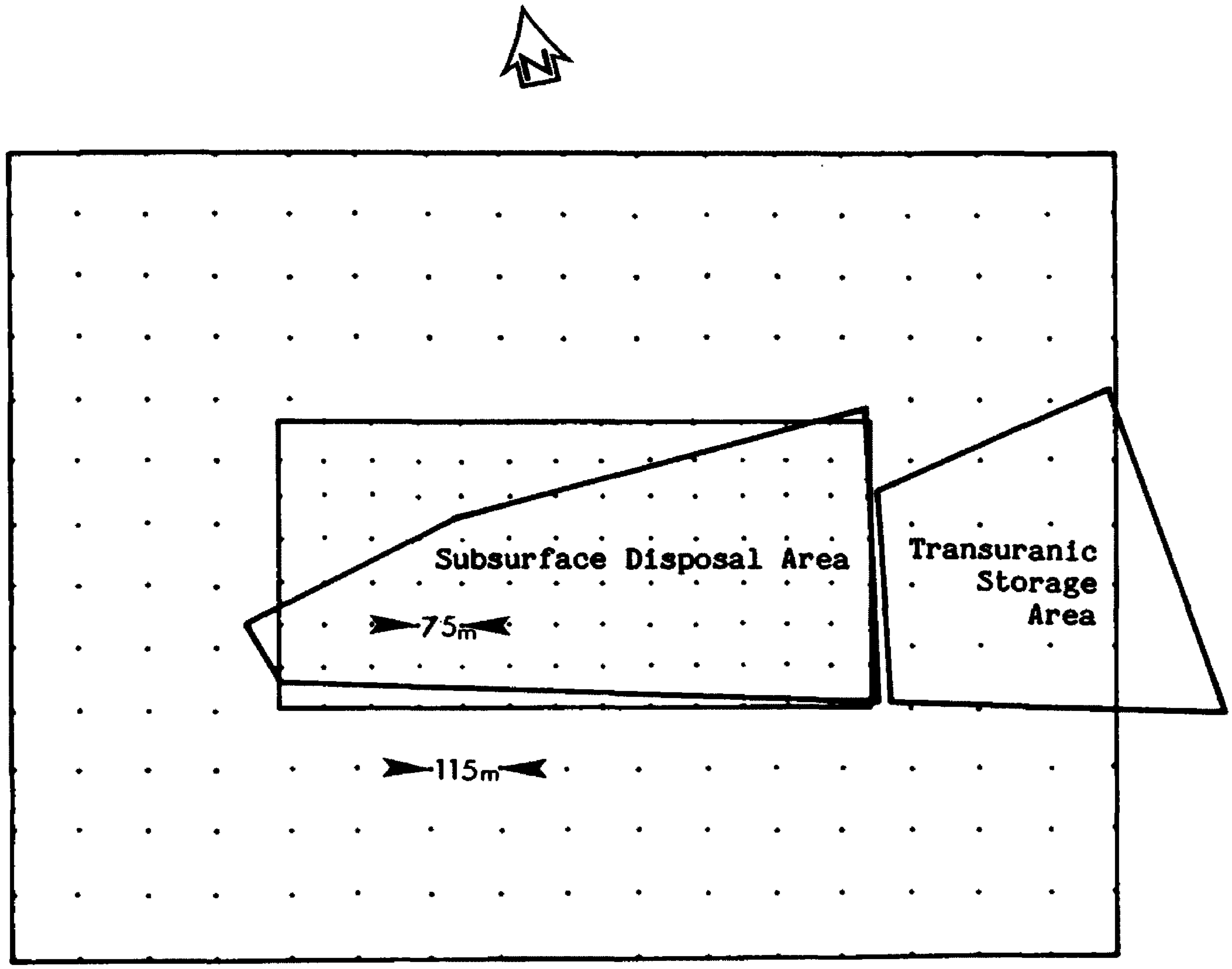

Fig. 3. Environmental sampling grid at the INEL Radioactive Waste Management Complex.

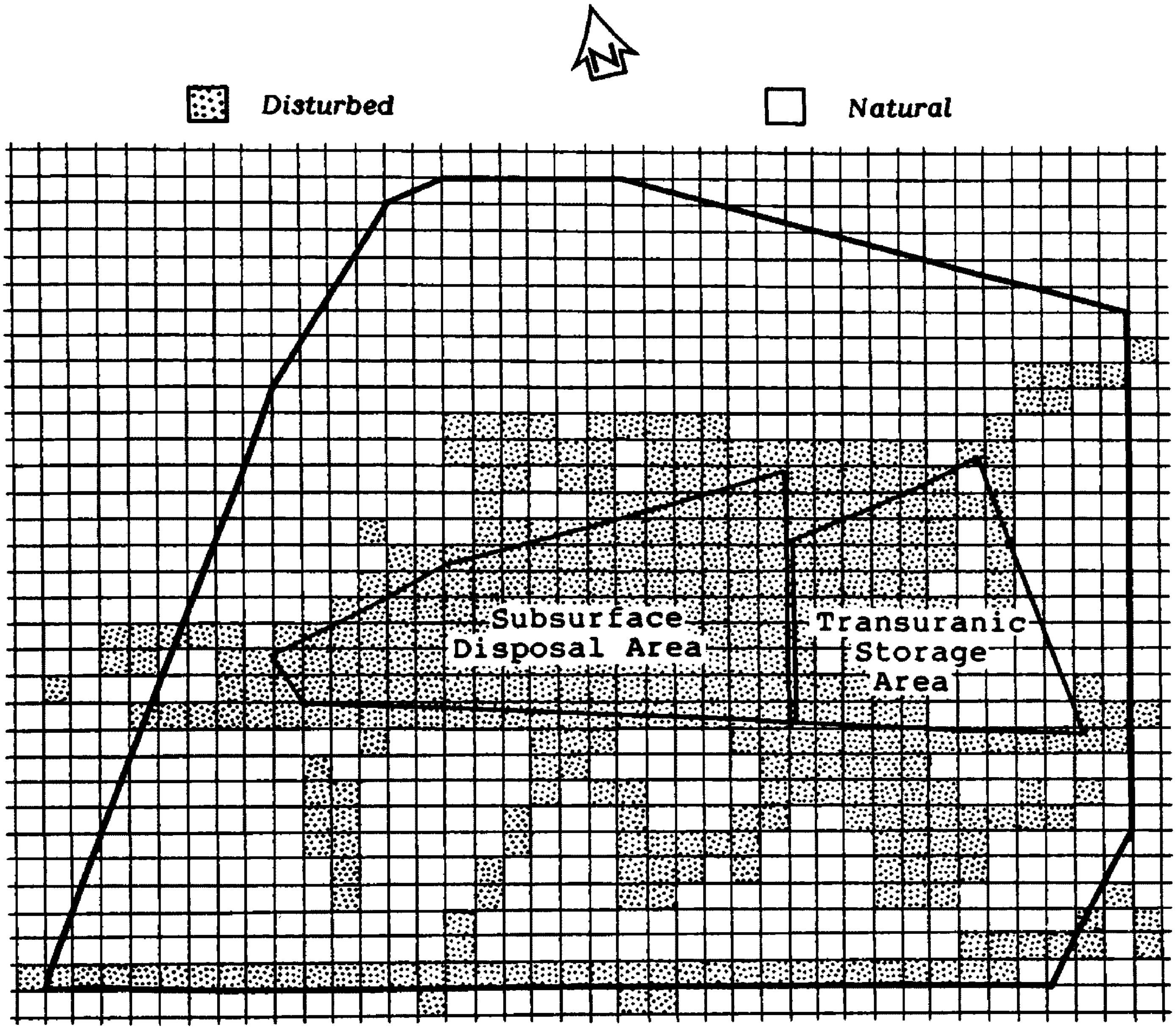

Fig. 4. Habitat distribution grid at the INEL Radioactive Waste Management Complex.

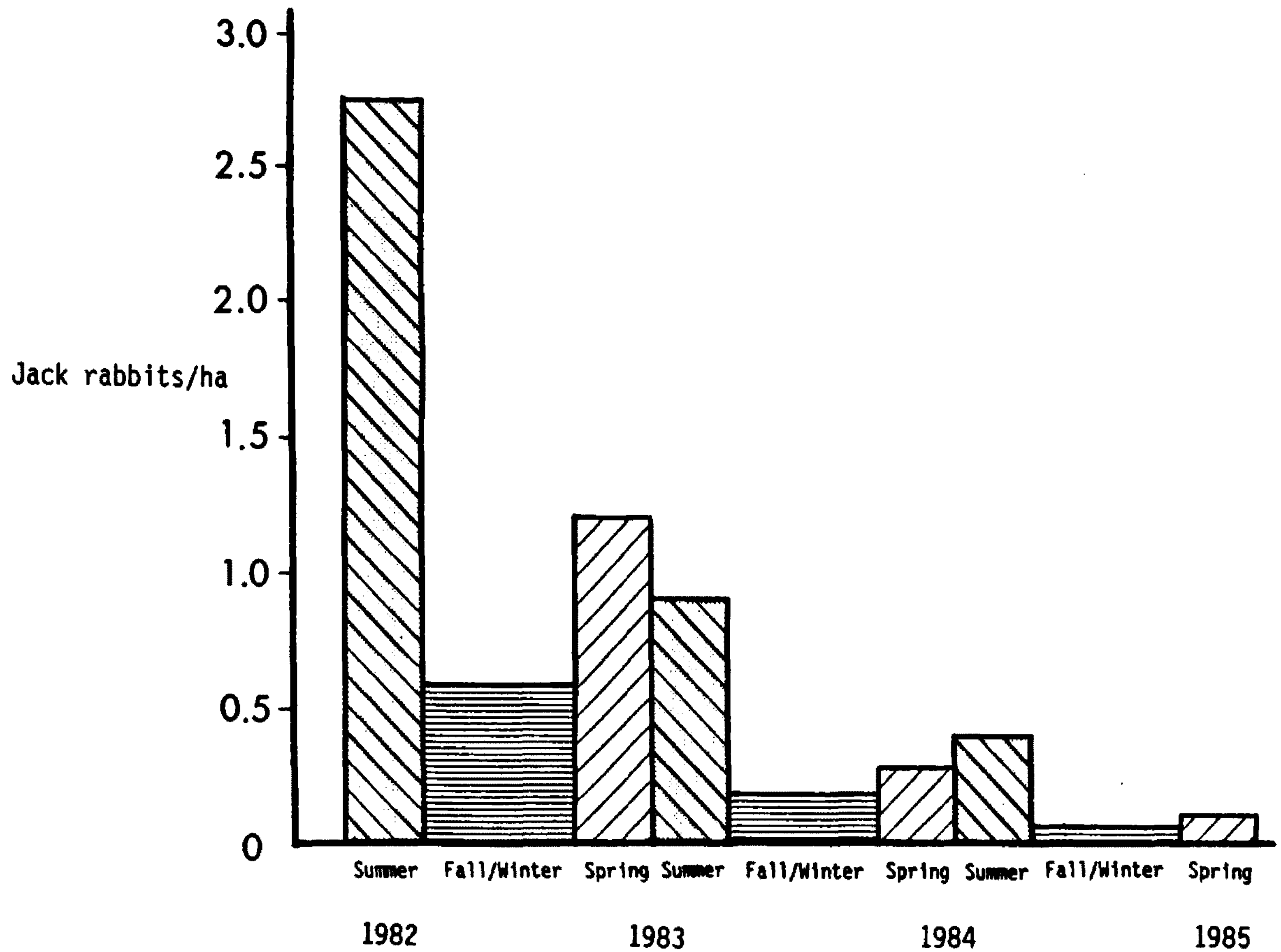

Fig. 5. Seasonal estimates of black-tailed jack rabbit population density at the INEL Radioactive Waste Management Complex based on fecal pellet accumulations.

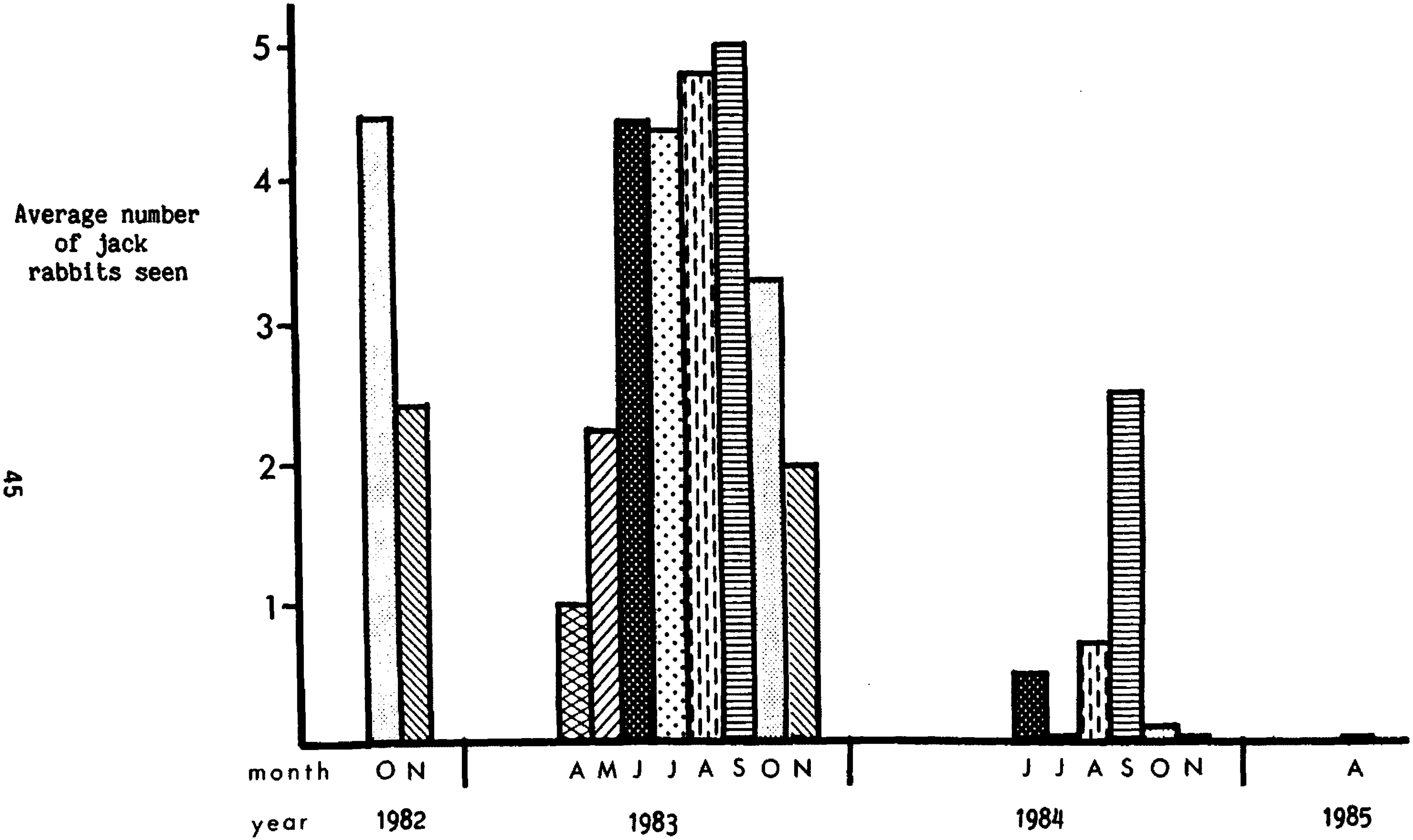

Fig. 6. Relative densities of black-tailed jack rabbits at the INEL Radioactive Waste Management Complex based on mean monthly number of jack rabbits observed along a 15 km spotlight survey route.

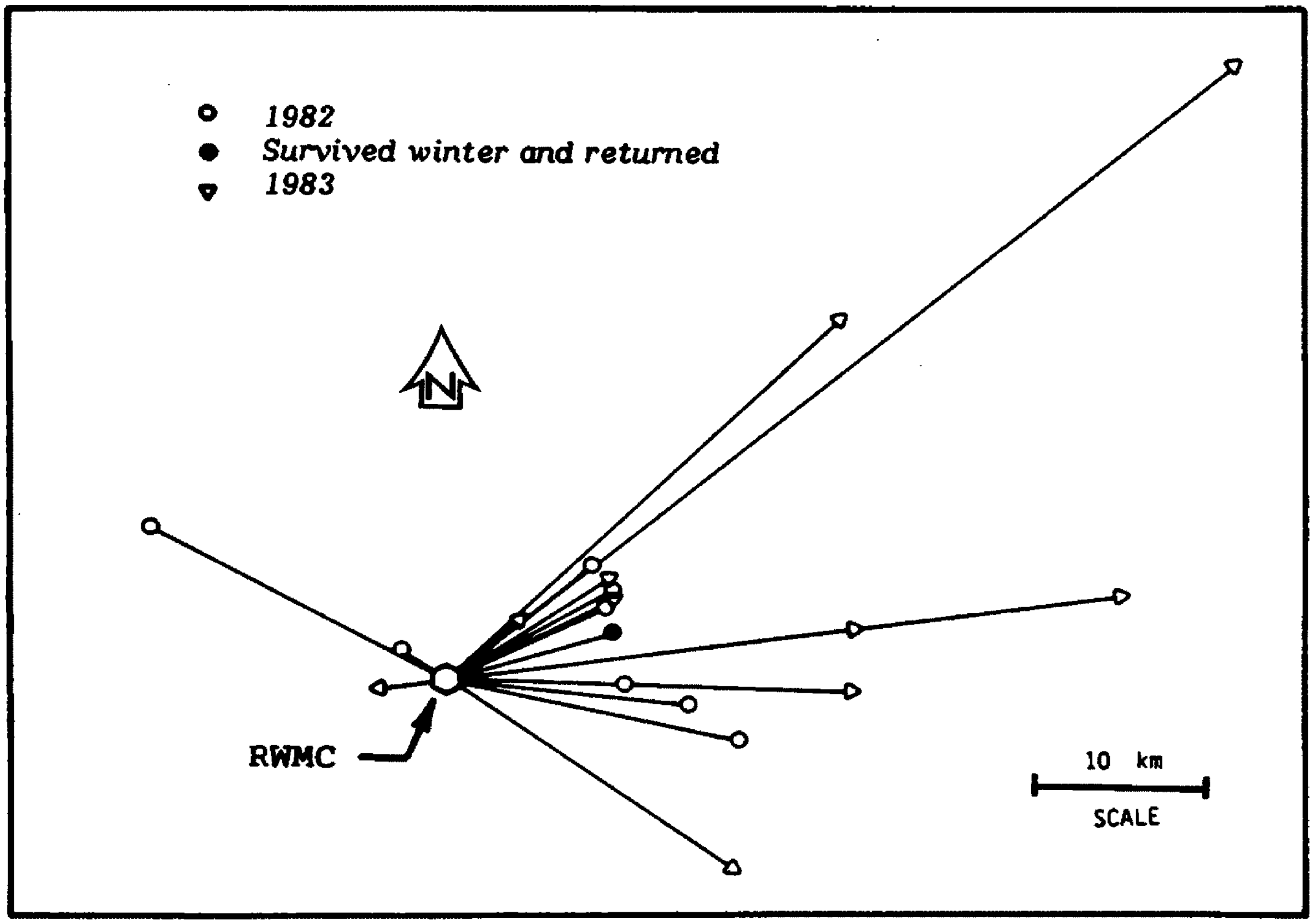

Fig. 7. Fall movements of black-tailed jack rabbits away from the INEL Radioactive Waste Management Complex.

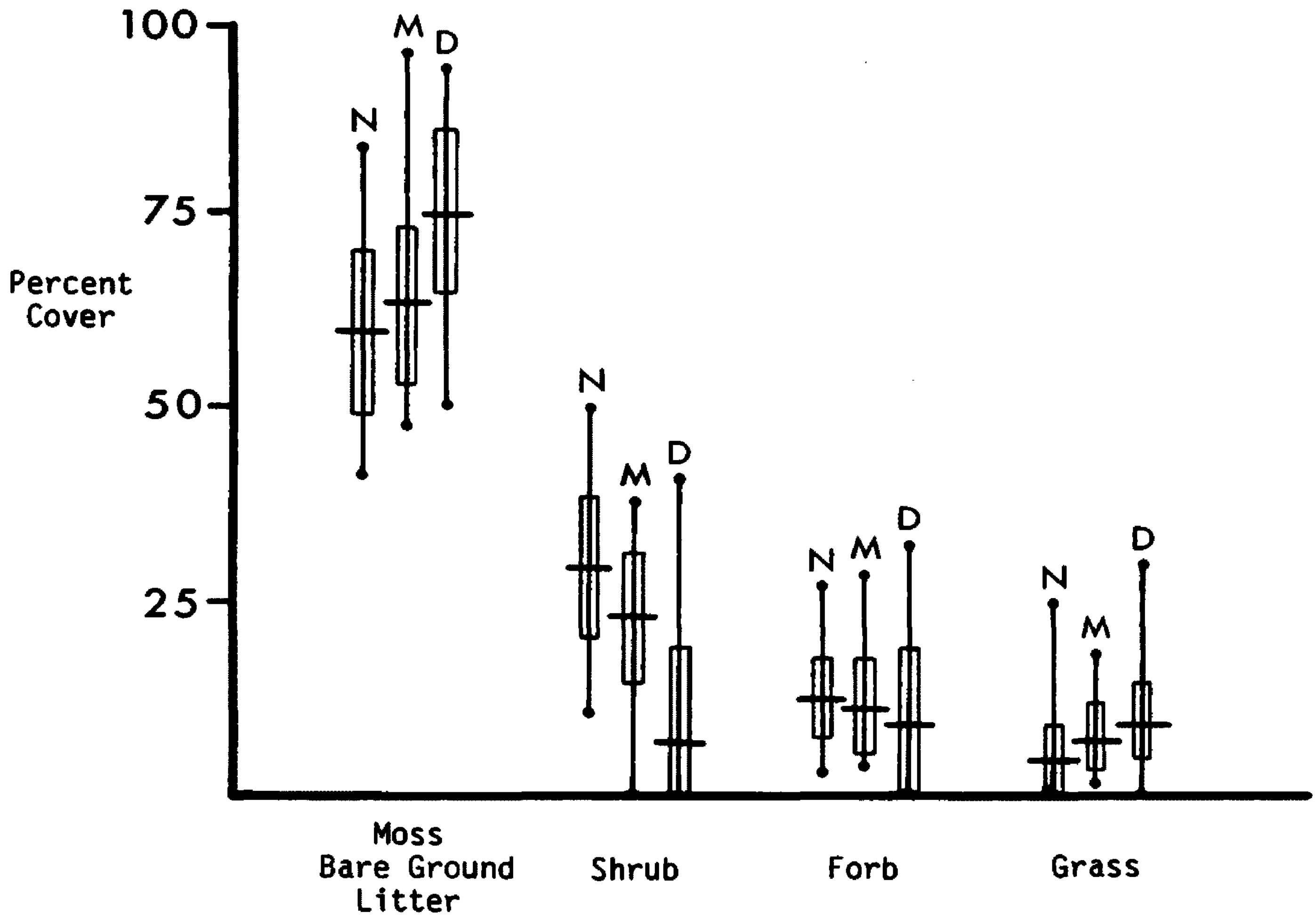

Fig. 8. Percent cover of shrub, forb, grass, and non-vascular plant entities on natural (N), mixed (M), and disturbed (D) vegetation plots at the INEL Radioactive Waste Management Complex.

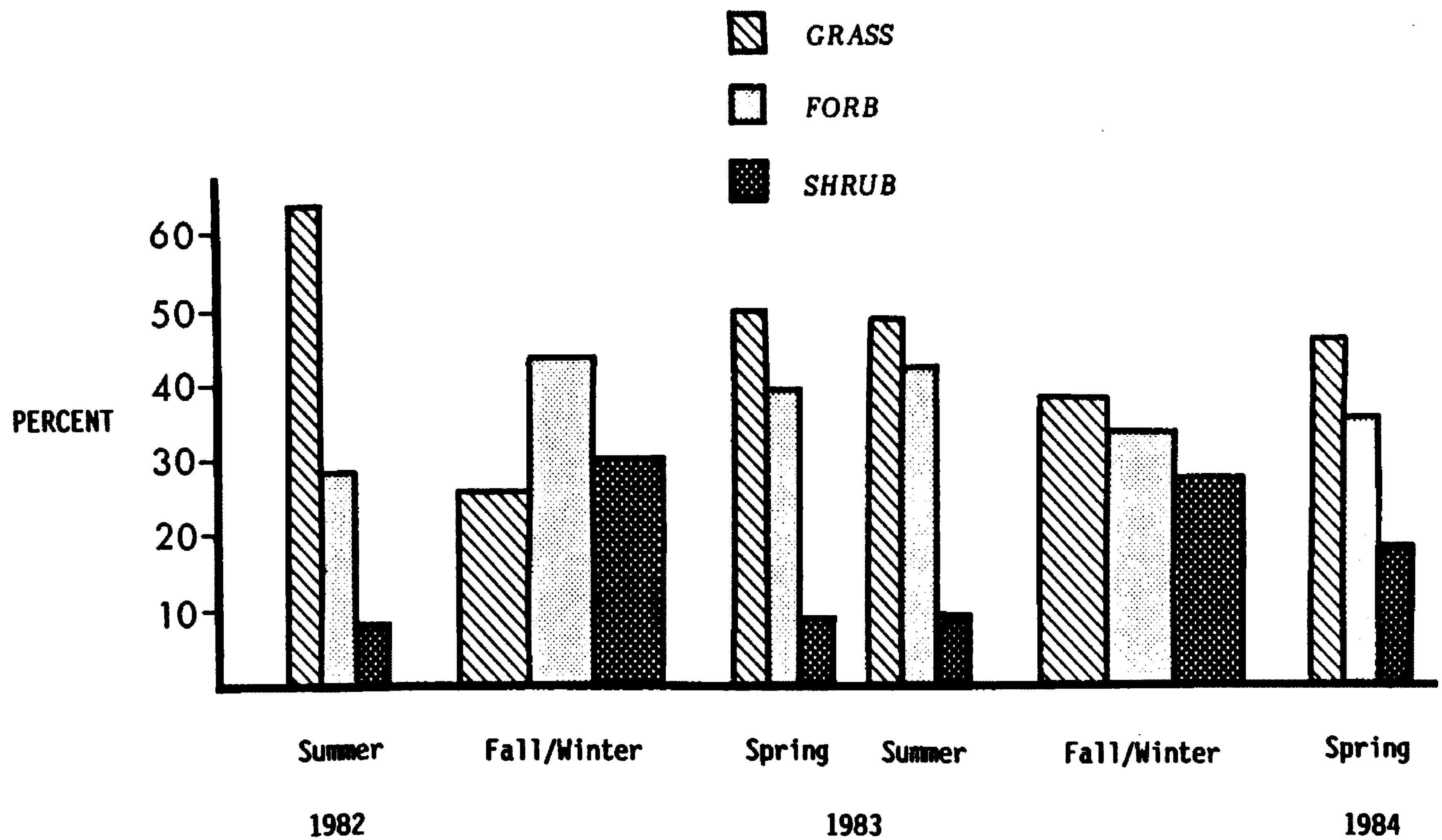

Fig. 9. Composition of seasonal black-tailed jack rabbit fecal samples.

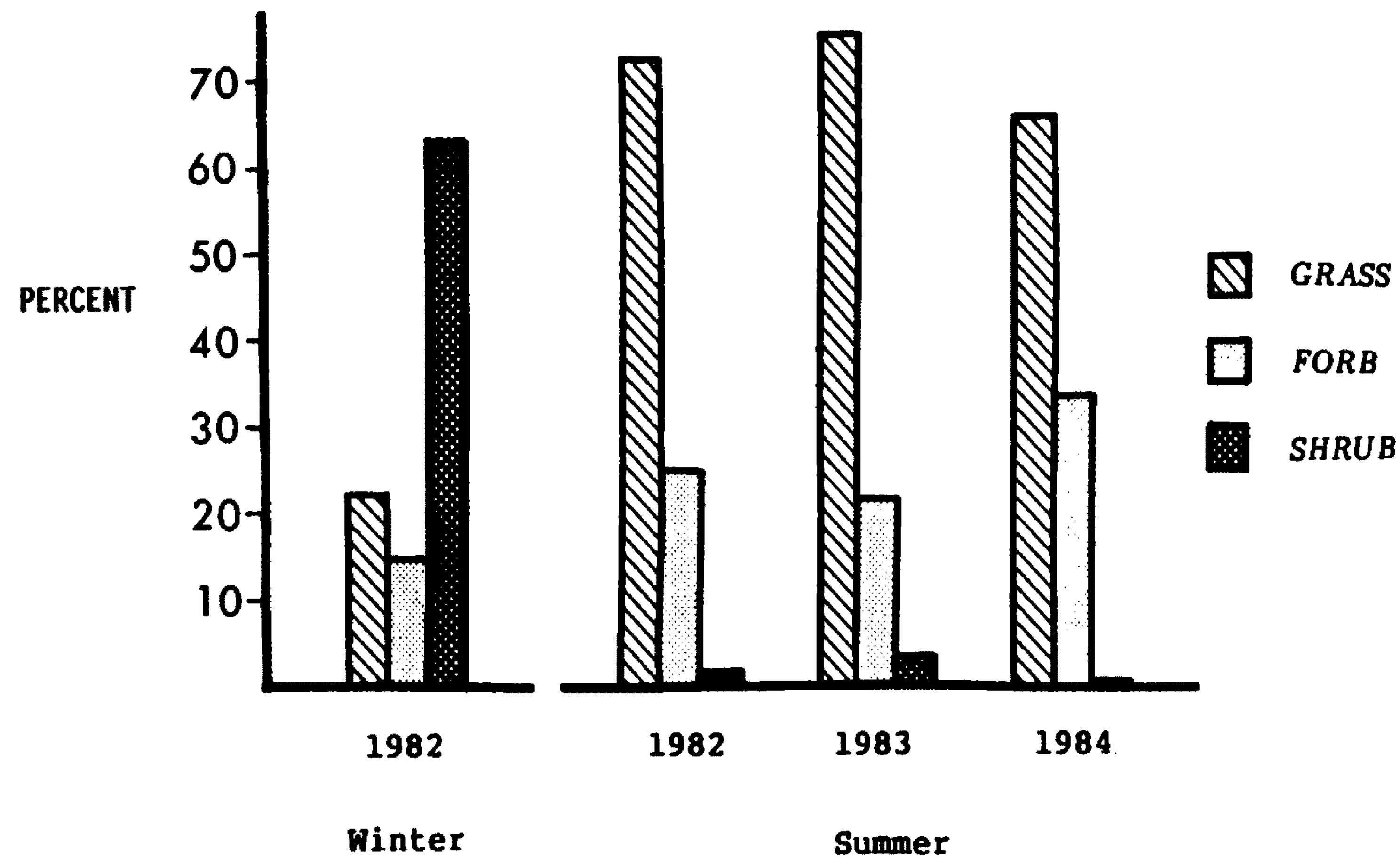

Fig. 10. Composition of winter and summer black-tailed jack rabbit fecal samples.

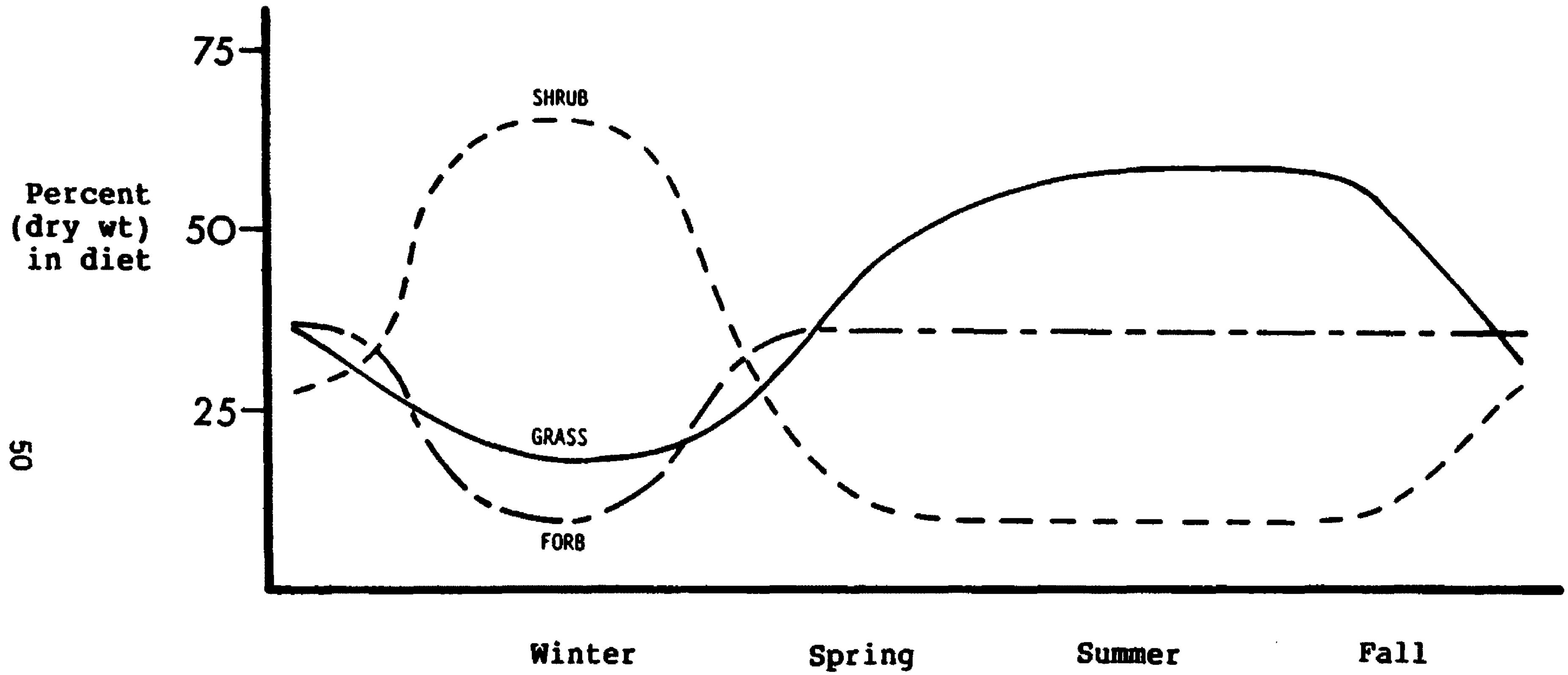

Fig. 11. Hypothetical model of annual diet of black-tailed jack rabbits at the INEL Radioactive Waste Management Complex.

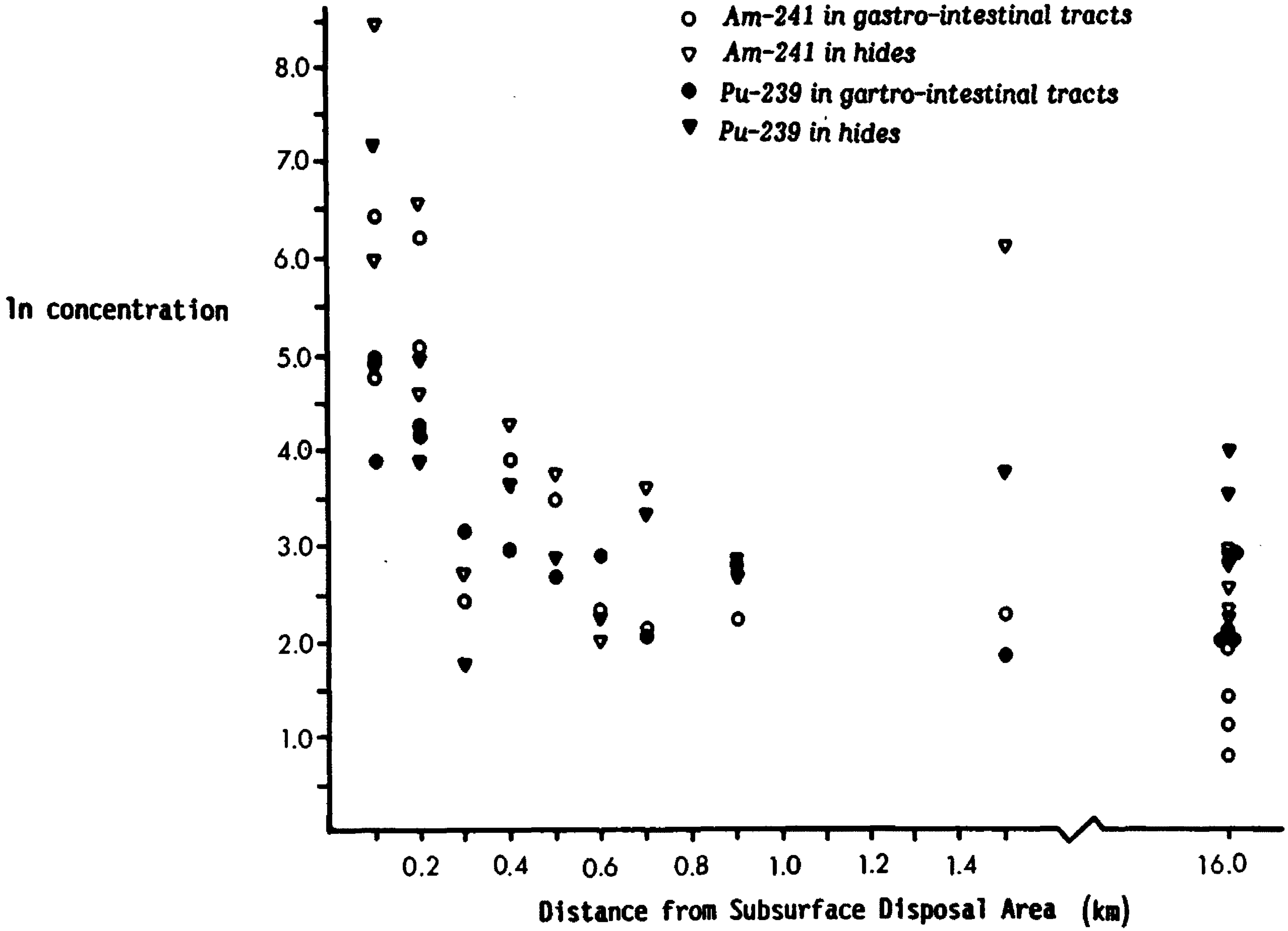

Fig. 12. Concentrations of Pu-239 and Am-241 in gastro-intestinal tracts and hides of black-tailed jack rabbits relative to distance from the RWMC Subsurface Disposal Area.

APPENDIX A

Size Distribution of Black-tailed Jack Rabbit and Nuttall's Cottontail Fecal Pellets Obtained from Boxtrapped Individuals.

Jack Rabbits >1000 g

ID number	Date	Size class >10 mm	<10 mm	<9 mm	<8 mm	<7 mm	<6 mm
J1	63083	0	0	3	4	1	0
J2	71183	10	11	6	0	0	0
J2	91283	0	9	18	12	3	0
J3	62983	39	30	11	0	0	0
J3	70683	0	10	14	6	1	0
J4	100883	0	0	5	1	0	0
J5	101283	0	1	15	12	4	0
J6	91083	1	0	26	20	0	0
J6	100883	0	0	0	6	0	0
J7	81883	0	3	2	0	0	0
J9	90983	0	0	2	4	2	0
J11	71383	12	15	11	1	0	0
J11	72583	1	1	1	0	0	0
J11	91283	34	20	26	18	1	0
J12	100783	0	0	2	4	0	0
J14	91683	0	0	1	40	24	0
J15	120984	0	7	53	70	18	0
Total		97	107	196	198	54	0

Jack rabbits <1000 g

ID number	Date	Size class >10 mm	<10 mm	<9 mm	<8 mm	<7 mm	<6 mm
J8	81983	0	0	6	77	69	0
J10	91383	0	0	1	48	40	0
J13	72983	0	0	0	2	6	0
Total		0	0	7	127	115	0

Cottontail

ID number	Date	Size class >10 mm	<10 mm	<9 mm	<8 mm	<7 mm	<6 mm
27	62983	0	0	11	37	39	5
168	81283	0	0	20	42	9	0
301	81083	0	0	41	135	51	4
303	81083	0	0	0	75	75	14
303	81183	0	0	0	0	78	39
303	81883	0	0	2	55	51	2
303	81983	0	0	0	0	29	70
303	90783	0	0	0	2	73	71
303	90883	0	0	0	1	16	0
303	90983	0	0	0	6	53	26
303	91083	0	0	0	0	43	113
305	90783	0	0	0	13	12	0
305	91283	0	0	0	3	62	0
305	91383	0	0	2	40	4	0
305	100883	0	0	0	0	22	12
307	90783	0	0	1	88	57	2
307	90883	0	0	0	1	2	84
307	91083	0	0	0	46	88	53
307	91183	0	0	0	0	10	69
309	90883	0	0	0	38	108	72
309	91183	0	0	0	49	63	27
311	90883	0	0	0	23	85	47
311	101283	0	0	0	0	35	45
313	91083	0	0	0	35	7	1
315	91183	0	0	0	28	33	30
315	100783	0	0	0	0	59	51
315	100883	0	0	0	0	14	75
315	101183	0	0	0	0	39	74
315	110483	0	0	0	0	1	71
315	110683	0	0	0	0	21	58
317	91483	0	0	0	49	80	2
321	91483	0	0	0	35	134	6
323	91483	0	0	0	3	127	85
323	100783	0	0	0	2	53	135
349	62484	0	0	0	20	98	29
351	62984	0	0	0	16	109	13
351	100783	0	0	0	0	12	168
365	110583	0	0	0	34	19	2
367	110483	0	0	0	0	28	1
372	71583	0	0	1	19	85	15
373	71183	0	0	3	43	68	23
373	72183	0	0	0	14	6	0
373	90883	0	0	0	4	74	19

Cottontail (continued)

ID number	Date	Size class >10 mm	<10 mm	<9 mm	<8 mm	<7 mm	<6 mm
373	90983	0	0	0	0	14	13
373	91083	0	0	0	0	24	31
373	91183	0	0	0	1	2	24
433	70883	0	0	7	41	19	2
436	70783	0	0	0	31	60	19
436	71183	0	0	17	75	70	17
436	71583	0	0	11	87	64	15
436	72283	0	0	3	31	71	22
436	72583	0	0	30	81	55	8
436	72683	0	0	0	26	17	0
436	81283	0	0	1	91	73	23
436	90783	0	0	1	52	55	21
436	90883	0	0	1	68	55	26
436	91183	0	0	0	74	67	3
436	91283	0	0	0	49	53	19
438	70583	0	0	0	5	7	0
440	70783	0	2	24	43	13	0
440	70183	0	0	3	133	30	2
440	90783	0	0	1	110	44	1
440	90983	0	0	0	4	82	24
440	91183	0	0	7	107	5	0
666	71383	0	3	55	68	42	0
777	62983	0	0	1	51	88	55
888	50783	0	0	4	31	39	17
999	119982	0	0	4	27	107	12
Total		0	5	251	2242	3288	1967

APPENDIX B

Plants Identified Near the INEL Radioactive Waste Management Complex.*

BORAGINACEAE

Cryptantha interrupta (Greene) Pays.	Bristly cryptantha
Cryptantha scoparia A. Nels.	Desert cryptantha
Lappula echinata Gilib.	Bristly stickseed
Lappula redowskii (Hornem.) Greene	Western stickseed

CACTACEAE

Opuntia polyacantha Haw.	Starvation cholla

CARYOPHYLLACEAE

Arenaria franklinii Dougl.	Franklin's sandwort

CHENOPODIACEAE

Chenopodium album L.	Lambsquarter
Eurotia lanata (Pursh) Moq.	Winterfat
Halogeton glomeratus Meyer	Halogeton
Kochia scoparia (L.) Schrad.	Summer cypress
Salsola kali (L.)	Russian thistle

COMPOSITAE

Antennaria microphylla Rydb.	Rosy pussy-toes
Artemisia ludoviciana Nutt.	Prairie sage
Artemisia tridentata Nutt.	Big sagebrush
Artemisia tripartita Rydb.	Threetip sagebrush
Balsamorhiza sagittata (Pursh) Nutt.	Arrowleaf balsamroot
Chaenactis douglasii (Hook.) H. and A.	Hoary false-yarrow
Chrysothamnus nauseosus (Pall.) Britt.	Gray rabbit-brush
Chrysothamnus viscidiflorus (Hook.) Nutt.	Green rabbit-brush
Cirsium arvense (L.) Scop.	Canadian thistle
Cirsium vulgare (Savi) Tenore	Bull thistle

COMPOSITAE (continued)

Crepis acuminata Nutt.	Tapertip hawksbeard
Eriogonum pumilis Nutt.	Shaggy fleabane
Gutierrezia sarothrae (Pursh) Britt. and Rusby.	Broom snakeweed
Haplopappus resinosus (Nutt.) Gray	Gnarled goldenweed
Iva axillaris Pursh	Poverty-weed
Lactuca serriola L.	Prickly lettuce
Machaeranthera canescens (Pursh) Gray	Hoary aster
Senecio canus Hook.	Woolly groundsel
Senecio integerrimus Nutt.	Western groundsel
Taraxacum officinale Weber	Common dandelion
Tetradymia canescens DC.	Gray horse-brush
Townsendia florifer (Hook.) Gray	Showy townsendia
Tragopogon dubius Scop.	Yellow salsify

CRUCIFERAE

Alyssum desertorum Stapf	Desert alyssum
Arabis lignifera Nels.	Woody-branch rockcress
Descurainia sophia (L.) Webb	Flixweed
Lepidium densiflorum Schrad.	Common pepperweed
Lepidium perfoliatum L.	Clasping pepperweed
Schoenocrambe linifolia (Nutt.) Greene	Plainsmustard
Sisymbrium altissimum L.	Jim Hill mustard
Thlaspi arvense L.	Fanweed

CUPRESSACEAE

Juniperus scropulorum Sarg.	Rocky Mountain juniper

EUPHORBIACEAE

Euphorbia esula L.	Esula spurge

GRAMINAE

Agropyron cristatum (L.) Gaerthn	Crested wheatgrass
Agropyron dasytachyum (Hook.) Scribn.	Thick-spiked wheatgrass
Agropyron smithii Rydb.	Bluestem wheatgrass
Agropyron spicatum (Pursh) Scribn. and Smith	Bluebunch wheatgrass
Bromus tectorum L.	Cheat grass

GRAMINAE (continued)

Elymus cinereus Scrib. and Merr.	Giant wildrye
Hordeum jubatum L.	Foxtail barley
Oryzopsis hymenoides (R. and S.) Ricker	Indian ricegrass
Poa sandbergii Vasey	Sandberg's bluegrass
Sitanion hystrix (Nutt.) Smith	Bottlebrush squireltail
Stipa commata Trin. and Rupr.	Needle-and-thread
Stipa thurberiana Piper	Thurber's needlegrass

LEGUMINOSAE

Astragalus convallarius Greene	Lesser rushy milk-vetch
Astragalus curvicarpus (Sheld.) Macbr.	Curvepod milk-vetch
Astragalus filipes Torr.	Threadstalk milk-vetch
Astragalus lentiginosus Dougl.	Speckled milk-vetch
Astragalus purshii Dougl.	Pursh's milk-vetch
Lupinus argenteus Pursh	Silvery lupine
Lupinus wyethii Wats.	Wyeth's lupine
Medicago sativa L.	Alfalfa
Melilotus officinalis (L.) Lam.	Yellow sweet-clover
Trifolium repens L.	White clover
Vicia sativa L.	Common vetch

LILIACEAE

Allium acuminatum Hook.	Hooker onion
Allium textile Nels. and Macbr.	Textile onion
Calochortus bruneaunis Nels. and Macbr.	Bruneau mariposa

MALVACEAE

Sphaeralcea munroana (Dougl.) Spach	Munro's globe-mallow

ONAGRACEAE

Gayophytum ramosissimum Nutt.	Hairstem gaoyphytum
Oenothera caespitosa Nutt.	Desert evening primrose

OROBANCHACEAE

Orobanche californica Cham. and Schlecht.	California broomrape

POLEMONIACEAE

Eriastrum sparsiflorum (Eastw.) Mason	Few-flowered eriastrum
Gilia congesta Hook.	Many-flowered gilia
Leptodactylon pungens (Torr.) Nutt.	Prickly phlox
Phlox hoodii Rich.	Hood's phlox
Phlox longifolia Nutt.	Long-leaf phlox

POLYGONACEAE

Eriogonum microthecum Nutt.	Slenderbush buckwheat
Eriogonum ovalifolium Nutt.	Cushion buckwheat
Polygonum aviculare L.	Knotweed
Rumex salicifolius Weinm.	Narrow-leaved dock

RANUNCULACEAE

Delphinium sp. L.	Larkspur

ROSACEAE

Potentilla biennis Greene	Biennial cinquefoil

SCROPHULARIACEAE

Castilleja angustifolia (Nutt.) G. Don	Northwest paintbrush
Cordylanthus ramosus Nutt.	Bushy birdbeak
Penstemon cyaneus Pennell	Dark-blue penstemon

UMBELLIFERAE

Cymopterus terebinthinus (Hook.) T. and G.	Turpentine cymopterus
Lomatium dissectum (Nutt.) Math. and Const.	Desert-parsley

*Plant names are from Hitchcock and Cronquist 1973.

APPENDIX C

Inventory of Radionuclide Burdens (pCi/g oven dry weight)
in Black-tailed Jack Rabbits Collected on the
Idaho National Engineering Laboratory.

Jack rabbit #1

Collected approximately 20 m north of SDA. Live weight 1510 g.

Radionuclide	G-I tract (41.10 g)	Hide (72.81 g)	Carcass (272.97 g)
K-40	0.0139 (0.0033)	0.00598 (0.0021)	NPD*
Co-58	NPD	0.000322 (0.00013)	NPD
Sr-90	0.253 (0.016)	0.23 (0.02)	0.64 (0.04)
Cs-137	0.0744 (0.16)	0.123 (0.13)	-0.0451 (0.058)
Pb-212	0.00052 (0.00021)	NPD	NPD
Pb-214	NPD	NPD	0.000326 (0.000080)
Pu-238	0.0005 (0.0002)	0.0053 (0.0006)	0.00025 (0.00011)
Pu-239/240	0.0134 (0.0009)	0.150 (0.006)	0.00086 (0.00012)
Am-241	0.063 (0.003)	0.51 (0.02)	0.0035 (0.0003)

Jack rabbit #2

Collected approximately 100 m north of SDA. Live weight 1720 g.

Radionuclide	G-I tract (59.02 g)	Hide (64.69 g)	Carcass (345.57 g)
K-40	0.0182 (0.0035)	0.00387 (0.0019)	0.00798 (0.0010)
Sr-90	0.09 (0.006)	0.30 (0.02)	0.295 (0.019)
Nb-94	NPD	NPD	0.000099 (0.000032)
Cs-137	-0.0543 (0.17)	-0.328 (0.15)	0.0129 (0.043)
Bi-214	NPD	0.000677 (0.00027)	NPD
Pu-238	0.0007 (0.0003)	0.0006 (0.0002)	0 (0.00009)
Pu-239/240	0.0048 (0.0005)	0.0127 (0.0008)	0 (0.00007)
Am-241	0.0116 (0.0010)	0.043 (0.002)	0.00013 (0.00010)

Jack rabbit # 3

Collected approximately 115 m north of SDA. Live weight 1475 g.

Radionuclide	G-I tract (49.29 g)	Hide (61.64 g)	Carcass (263.95 g)
K-40	0.00111 (0.0031)	NPD	0.00987 (0.0014)
Sr-90	0.121 (0.009)	0.313 (0.019)	0.117 (0.011)
Cs-137	0.332 (0.19)	-0.0557 (0.19)	-0.112 (0.073)
Bi-214	NPD	NPD	0.000480 (0.00012)
Pb-212	NPD	0.000279 (0.00019)	0.000157 (0.000082)
Pu-238	0.0008 (0.0002)	0.00050 (0.00018)	0 (0.00009)
Pu-239/240	0.0068 (0.0006)	0.0154 (0.0009)	0.00018 (0.00009)
Am-241	0.052 (0.002)	0.075 (0.004)	0.00085 (0.00019)

Jack rabbit #4

Collected approximately 125 m northwest of SDA. Live weight 2075 g.

Radionuclide	G-I tract (73.92 g)	Hide (112.88 g)	Carcass (414.81 g)
K-40	0.0130 (0.0027)	NPD	0.00831 (0.0011)
Sr-90	0.064 (0.006)	0.239 (0.016)	0.248 (0.017)
Cs-137	0.0436 (0.13)	0.0309 (0.12)	-0.00323 (0.052)
Pb-214	NPD	NPD	0.000165 (0.000060)
Pu-238	0.00071 (0.00019)	0.00070 (0.00018)	0.00055 (0.00015)
Pu-239/240	0.0073 (0.0005)	0.0049 (0.0005)	0.00038 (0.00012)
Am-241	0.0165 (0.0010)	0.0103 (0.0005)	0.00018 (0.00014)

Jack rabbit #5

Collected approximately 200 m south of SDA. Live weight 2100 g.

Radionuclide	G-I tract (55.46 g)	Hide (116.94 g)	Carcass (458.25 g)
K-40	0.0121 (0.0021)	NPD	0.00663 (0.00085)
Sr-90	0.061 (0.004)	0.011 (0.002)	0.262 (0.017)
Cs-137	-0.137 (0.16)	0.0456 (0.079)	-0.0806 (0.048)
Tl-208	NPD	NPD	0.000252 (0.000078)
Bi-214	0.000429 (0.00023)	NPD	NPD
Pb-214	NPD	NPD	0.000177 (0.000069)
Pu-238	0.0005 (0.0002)	0 (0.00012)	0.00011 (0.00006)
Pu-239/240	0.0024 (0.0004)	0.00066 (0.00017)	0.00009 (0.00005)
Am-241	0.0012 (0.0003)	0.0015 (0.0006)	0 (0.00007)

Jack rabbit #6

Collected approximately 350 m south of SDA. Live weight 1630 g.

Radionuclide	G-I tract (31.67 g)	Hide (58.64 g)	Carcass (260.51 g)
K-40	0.0129 (0.0045)	0.00690 (0.0030)	0.00502 (0.0013)
Sr-90	0.061 (0.008)	0.191 (0.014)	0.167 (0.012)
Cs-137	0.230 (0.14)	0.399 (0.22)	-0.0398 (0.059)
Bi-212	NPD	NPD	0.00155 (0.00063)
Pu-238	0.0004 (0.0003)	0.0004 (0.0002)	0 (0.00010)
Pu-239/240	0.0019 (0.0005)	0.0042 (0.0006)	0.00025 (0.00010)
Am-241	0.005 (0.002)	0.0079 (0.0008)	0.0005 (0.0003)

Jack rabbit #7

Collected approximately 500 m south of SDA. Live weight 1650 g.

Radionuclide	G-I tract (46.78 g)	Hide (72.69 g)	Carcass (352.01 g)
K-40	0.0121 (0.0028)	0.00302 (0.0014)	0.0101 (0.0012)
Sr-90	0.158 (0.010)	0.34 (0.02)	0.299 (0.018)
Cs-137	0.0639 (0.087)	-0.138 (0.13)	0.0711 (0.063)
Pu-238	0.0004 (0.0002)	0.00035 (0.00016)	0.00028 (0.00011)
Pu-239/240	0.0015 (0.0003)	0.0019 (0.0003)	0.00008 (0.00008)
Am-241	0.0035 (0.0005)	0.0045 (0.0012)	0.00011 (0.00008)

Jack rabbit #8

Collected approximately 510 m east of SDA. Live weight 2010 g.

Radionuclide	G-I tract (66.33 g)	Hide (39.41 g)	Carcass (402.40 g)
K-40	NPD	0.00961 (0.0033)	0.00905 (0.0012)
Sr-90	0.100 (0.008)	0.049 (0.008)	0.261 (0.018)
Cs-137	0.0620 (0.13)	-0.0864 (0.27)	-0.0651 (0.053)
Tl-208	NPD	NPD	0.000314 (0.000086)
Pu-238	0.0014 (0.0003)	0.0023 (0.0005)	0 (0.00005)
Pu-239/240	0.0018 (0.0003)	0.0010 (0.0003)	0.00007 (0.00005)
Am-241	0.0011 (0.0003)	0.0009 (0.0004)	-0.00005 (0.00005)

Jack rabbit #9

Collected approximately 625 m east of SDA. Live weight 1725 g.

Radionuclide	G-I tract (50.94 g)	Hide (65.66 g)	Carcass (319.86 g)
K-40	0.00966 (0.0024)	NPD	0.0109 (0.0013)
Sr-90	0.076 (0.008)	0.288 (0.019)	0.217 (0.014)
Cs-137	0.00407 (0.13)	0.439 (0.11)	0.0859 (0.067)
Pb-212	NPD	NPD	0.000095 (0.000065)
Pu-238	0.0010 (0.0003)	0.00058 (0.00018)	0.00008 (0.00008)
Pu-239/240	0.0009 (0.0003)	0.0031 (0.0004)	0.00010 (0.00008)
Am-241	0.0009 (0.0003)	0.0040 (0.0005)	0.00021 (0.00010)

Jack rabbit #10

Collected approximately 850 m east of SDA. Live weight 1760 g.

Radionuclide	G-I tract (47.98 g)	Hide (74.00 g)	Carcass (345.72 g)
K-40	0.0152 (0.0028)	0.00469 (0.0021)	0.00925 (0.0012)
Sr-90	0.110 (0.009)	0.236 (0.017)	0.221 (0.014)
Cs-137	0.411 (0.13	0.0255 (0.17)	-0.00418 (0.060)
Bi-214	NPD	0.000267 (0.00019)	NPD
Pu-238	0.0014 (0.0003)	0.00089 (0.00016)	0.00008 (0.00010)
Pu-239/240	0.0018 (0.0003)	0.0019 (0.0002)	0.00018 (0.00008)
Am-241	0.0010 (0.0004)	0.0016 (0.0004)	0.0010 (0.0002)

Jack rabbit #11

Collected approximately 2200 m east of SDA. Live weight 1750 g.

Radionuclide	G-I tract (54.08 g)	Hide (38.07 g)	Carcass (355.73 g)
Be-7	0.00572 (0.0017)	NPD	NPD
K-40	0.00757 (0.0022)	0.00522 (0.0034)	0.00718 (0.0011)
Sr-90	0.071 (0.005)	0.103 (0.007)	0.107 (0.008)
Cs-137	-0.0883 (0.11)	-0.0338 (0.19)	0.0319 (0.050)
Tl-208	NPD	0.000878 (0.00051)	NPD
Pu-238	0.0012 (0.0003)	0.0013 (0.0003)	0 (0.00009)
Pu-239/240	0.00076 (0.00019)	0.0052 (0.0006)	0.00010 (0.00008)
Am-241	0.0012 (0.0003)	0.056 (0.005)	0.00032 (0.00010)

Jack rabbit #12

Colleted approximately 16 km northeast of SDA. Live weight 1830 g.

Radionuclide	G-I tract (56.81 g)	Hide (64.12 g)	Carcass (350.14 g)
K-40	0.0121 (0.0026)	0.00690 (0.0019)	0.0127 (0.0014)
Sr-90	0.097 (0.007)	0.195 (0.014)	0.202 (0.013)
Cs-137	0.202 (0.12)	-0.0729 (0.18)	0.00261 (0.064)
Pu-238	0.0009 (0.0003)	0.0012 (0.0003)	0.00036 (0.00012)
Pu-239/240	0.0010 (0.0003)	0.0021 (0.0003)	0.00024 (0.00012)
Am-241	0.0009 (0.0002)	0.0016 (0.0003)	0.00012 (0.00007)

Jack rabbit #13

Collected approximately 16 km northeast of SDA. Live weight 1450 g.

Radionuclide	G-I tract (55.80 g)	Hide (61.05 g)	Carcass (264.73 g)
K-40	0.0100 (0.0029)	NPD	NPD
Sr-90	0.080 (0.006)	0.30 (0.02)	0.223 (0.015)
Cs-137	0.368 (0.16)	0.126 (0.14)	0.0822 (0.051)
Pu-238	0.0003 (0.0003)	0.0015 (0.0003)	0 (0.00014)
Pu-239/240	0.0009 (0.0003)	0.0068 (0.0006)	0.00008 (0.00017)
Am-241	0.0003 (0.0002)	0.0025 (0.0004)	0.00024 (0.00011)

Jack rabbit #14

Collected approximately 16 km northeast of SDA. Live weight 2275 g.

Radionuclide	G-I tract (75.28 g)	Hide (102.59 g)	Carcass (435.19 g)
K-40	0.00908 (0.0024)	0.00364 (0.0014)	0.00413 (0.00076)
Sr-90	0.090 (0.006)	0.284 (0.018)	0.288 (0.019)
Cs-137	-0.0733 (0.0057)	0.0158 (0.096)	0.0295 (0.035)
Bi-214	0.000492 (0.00021)	NPD	NPD
Pu-238	0.0002 (0.0002)	0.0013 (0.0003)	0 (0.00011)
Pu-239/240	0.0009 (0.0003)	0.0023 (0.0003)	0.00022 (0.0008)
Am-241	0.00037 (0.00037)	0.00120 (0.00017)	0.00020 (0.00009)

Jack rabbit #15

Collected approximately 16 km northeast of SDA. Live weight 1820 g.

Radionuclide	G-I tract (69.84 g)	Hide (77.98 g)	Carcass (315.81 g)
K-40	0.0124 (0.0024)	NPD	0.00791 (0.0013)
Sr-90	0.078 (0.006)	0.36 (0.02)	0.38 (0.03)
Cs-137	-0.140 (0.17)	0.0621 (0.055)	0.0370 (0.046)
Tl-208	NPD	0.000450 (0.00023)	NPD
Pu-238	0.00037 (0.00019)	0.0016 (0.0003)	0.00012 (0.00010)
Pu-239/240	0.0024 (0.0003)	0.0041 (0.0004)	0.00031 (0.00010)
Am-241	0.00050 (0.00019)	0.0013 (0.0003)	0 (0.00009)

*No peak detected.